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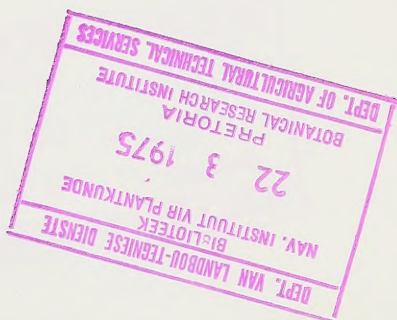
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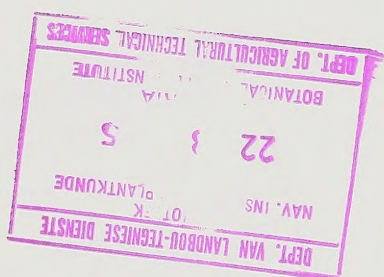
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CONTENTS

	Page
SOME PROBLEMS ARISING FROM THE PRELIMINARY MANIPULATION OF PLANT ECOLOGICAL DATA FOR SUBSEQUENT NUMERICAL ANALYSIS. B. H. Walker	1
STAPELIEAE (ASCLEPIADACEAE) FROM SOUTH TROPICAL AFRICA: 8. L. C. Leach	15
DISCRIMINANT ANALYSIS USED TO DETECT POPULATION VARIATION AMONGST GRASSES COLLECTED ON MINE DUMPS. F. M. Thatcher and R. A. Lubke	27
ROBERT BROWN AT THE CAPE OF GOOD HOPE. J. P. Rourke	47
THE IDENTITY OF <i>EUCOMIS NANA</i> (Burm.f.) L'HERIT. W. F. Reyneke	61
PRELIMINARY STUDIES ON SEED GERMINATION OF <i>DROSERA ALICIAE</i> HAMET. D. P. Ferreira and J. G. C. Small	65
MEGASPOROGENESIS AND MEGAGAMETOGENESIS IN <i>ALOE AFRICANA</i> MILL. J. E. McNaughton and B. L. Robertson	75
BOOK REVIEWS: Common Trees of the Highveld by R. B. Drummond and K. Coates Palgrave. (J. P. Rourke). Trees of the Kruger National Park Vol. 1, by P. van Wyk. (J. P. Rourke). Principles of Dispersal in Higher Plants by L. van der Pyl. (P. G. Jordaan). Die Vegetation des Mecsekge- birges und Seiner Umgebung deur A. O. Horvát. (P. G. Jordaan)	81
STUDIES IN THE GENERA OF THE <i>DIOSMEAE</i> (RUTA- CEAE): 3. I. Williams	85
A SCANNING ELECTRON MICROSCOPIC INVESTIGATION OF THE POLLEN OF SOUTH AFRICAN <i>ACACIA</i> SPECIES. P. J. Robbertse	91

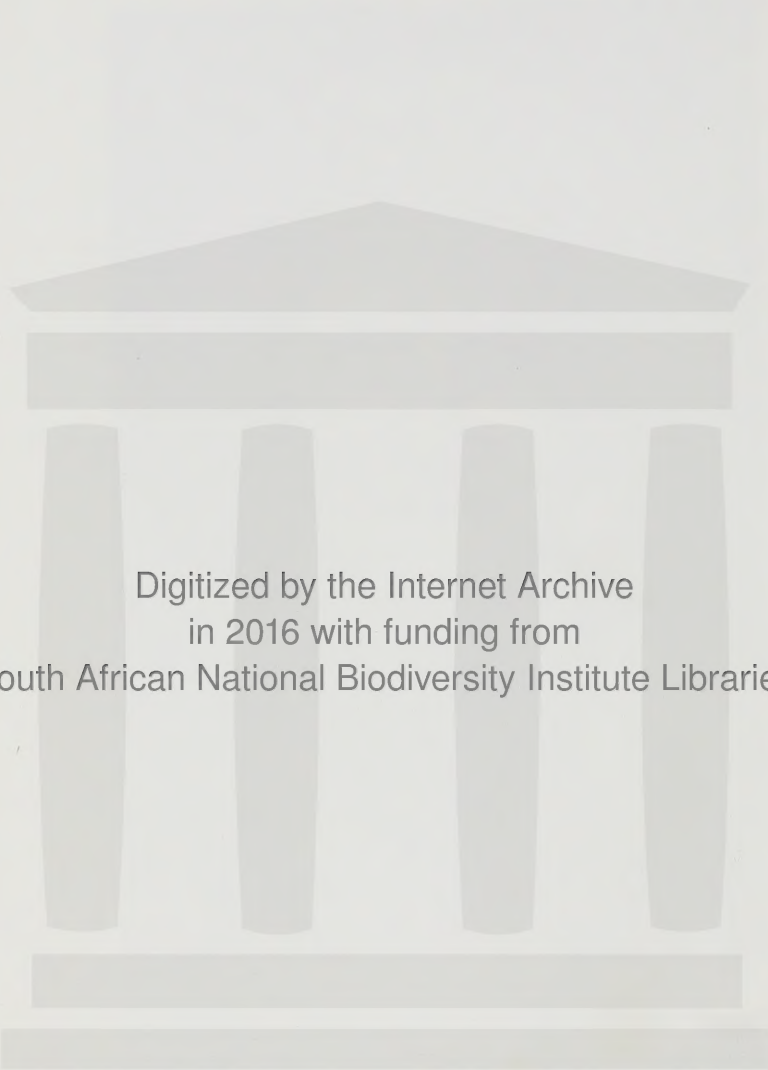
	Page
NOTES ON THE ALOES OF S. TROPICAL AFRICA WITH FOUR NEW SPECIES AND A NEW VARIETY. L. C. Leach	101
THELYPTERIDACEAE OF AFRICA AND ADJACENT ISLANDS. R. E. Holttum	123
HETEROSTYL IN SOUTH AFRICAN FLOWERING PLANTS: A CONSPECTUS. R. Ornduff	169
CELL DIVISION-INDUCING SUBSTANCES IN THE LIQUID ENDOSPERM OF <i>HYPHAENE NATALENSIS</i> . J. van Staden	189
ABSCISSION OF LEAVES IN <i>GREYIA</i> HOOK. AND HARV. E. Steyn	193
DIE SUID-AFRIKAANSE GENUS <i>SYRINGODEA</i> . M. P. de Vos	201
BOOK REVIEWS: Endogenous Plant Growth Substances by T. A. Hill. (J. van Staden). Microautoradiography and Electron Probe Analysis edited by U. Lüttge. (C. H. Bornman)	255
THE ALPINE VEGETATION OF THE LESOTHO DRAKENS- BERG. S. N. Herbst and B. R. Roberts	257
ONTKIEMING VAN DORINGBOOMSAAD. P. J. Robbertse .	269
STUDIES IN THE GENERA OF THE <i>DIOSMEA</i> (RUTA- CEAE): 4. I. Williams	275
NOTES ON <i>PROTEA</i> IN SOUTH AFRICA. J. P. Rourke . .	291
<i>DUTHIELLA</i> , 'N NUWE GENUS VAN DIE IRIDACEA. M. P. de Vos	301
A NEW SPECIES OF <i>SUTERA</i> (SCROPHULARIACEAE). P. Bond	311
<i>PYRRHOPAPPUS TARAXACOIDES</i> , A SYNONYM OF <i>TARAXACUM FULVIPILLIS</i> . D. K. Northington	313
A CHEMOTAXONOMIC STUDY OF TWELVE SPECIES OF THE FAMILY LORANTHACEAE: P. M. Tilney and R. A. Lubke	315
BOOK REVIEW: Ferns of the Witwatersrand by Florence D. Hancock and Annabelle Lucas (E. A. Schelpe)	333



THIS VOLUME IS DEDICATED TO

INEZ CLARE VERDOORN (1896—)

formerly officer in charge of the National Herbarium, Pretoria, and recognized authority on numerous plant groups, for example *Encephalartos*, *Welwitschia*, *Aloe*, *Crinum*, *Hermannia*, Oleaceae, Salvadoraceae, Loganiaceae and Gentianaceae, one of the instigators of the Flora of Southern Africa and kindly mentor to a long line of taxonomists in the National Herbarium, past president of the South African Biological Society and recipient of the Senior Captain Scott Memorial Medal of that Society, active supporter and past sectional president of the South African Society for the Advancement of Science, honorary Doctor of Philosophy of the University of Natal, whose contributions have added immensely to the prestige of South African botany.



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SOME PROBLEMS ARISING FROM THE PRELIMINARY MANIPULATION OF PLANT ECOLOGICAL DATA FOR SUBSEQUENT NUMERICAL ANALYSIS

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ABSTRACT

The increasing use of multivariate methods in analysis of ecological data demands that more attention be paid to the validity of results being obtained. An area of weakness in the application of these techniques lies in the form that the data should take before they are analyzed. Initial manipulation of the data, or the lack thereof, strongly influences the outcome of the analysis. This paper is for the interest of non-mathematical ecologists and attempts to describe some of the problems associated with importance values, the presence of zero-values, standardization of data, the use of relative values, and distortions due to non-linearity of the data. It is concluded that there is seldom a best method of transformation and analysis, and that for any particular analytical procedure more than one analysis should be made on different transformations of the data. Although producing apparently different answers, each may be valid, emphasizing different aspects of the data.

UITTREKSEL

PROBLEME AS GEVOLG VAN DIE VOORAFGAANDE MANIPULASIE VAN PLANTEKOLOGIESE DATA VIR NUMERIESE ANALISE

Die toenemende gebruik van veelvuldige veranderlike metodes by die ontleding van ekologiese gegewens vereis dat meer aandag bestee moet word aan die geldigheid van uitslae wat verwerf word. 'n Swakheid by die toepassing van hierdie tegnieke lê by die vorm wat die gegewens behoort aan te neem voordat hulle ontleed word. Aanvanklike bewerking van die gegewens, of die gebrek daaraan beoefen 'n sterk invloed oor die uitslag van die ontleding uit. Hierdie verhandeling word gerig aan nie-wiskundige ekoloë en poog om sommige van die probleme verbonde aan gewigswaardes, die aanwesigheid van nulwaardes, standaardisering van gegewens, die gebruik van relatiewe waardes en distorsie weens nie-lineêre gegewens, te beskryf. Dit word afgelei dat daar selde 'n besondere metode van omskepping en ontleding is. Vir enige bepaalde analitiese werkswyse behoort meer as een ontleding op verskillende omskeppings van gegewens gemaak te word. Alhoewel dit klaarblyklik verskillende antwoorde afgee, mag elk geldig wees deurdat verskillende aspekte van die gegewens beklemtoon word.

INTRODUCTION

The rapid increase in development and application of numerical methods in plant ecology carries with it considerable promise for improving the understanding of vegetation/environment relationships. However, it also gives rise to a number of problems, associated with the basic nature of ecological data, that can lead to invalid results. It is unfortunate that in many instances research workers who use multivariate techniques have insufficient background to properly evaluate the array of methods with which they are confronted, and

since it is neither desirable nor possible to offer a cut-and-dried recipe for ecological research, there is a need for general, non-mathematical accounts of common problems that arise in the use of numerical methods. The great danger is that a lack of appreciation of basic assumptions about the nature of the data can lead to spurious patterns emerging from the analysis, and being accepted by a researcher whose wide range of activities prevents him from devoting the time required to fully comprehend the output of a complex analysis.

This paper is not aimed at statistical ecologists, and is not intended to be a critical account of multivariate analyses. Its objectives are to demonstrate some of the common problems arising from the preparation of data for subsequent numerical analysis. It is hoped that it may help to clarify the situation for those who wish only to use the methods for what they really are—ecological research tools. The rationale of particular methods is omitted (except where pertinent to alternatives in data transformation) and attention is limited to the suitability of various forms of data. For those who wish to delve deeper, the mathematical bases for transformation in general statistical procedures are to be found in Patil *et al.* (1971), and the papers by Williams (1971) and Austin and Greig-Smith (1968) should also be consulted. For the field ecologist, Greig-Smith (1971a) and Dagnelie (1971) present a non-mathematical account of what some of the procedures can and cannot do and cover the factors involved in the choice of technique for any particular problem. The review by Goodall (1970) summarizes the present status of statistical plant ecology.

One of the main weaknesses in the application of multivariate techniques to plant ecological data seems to be the loose definition of what the raw species values are supposed to represent, and the often arbitrary manipulation of these data (standardization, weighting, etc.) as a preliminary step in their analysis. Apart from the special case of presence and absence data the final scores given to each species in each of the sites (stands) will clearly play a major role in determining the nature of the results obtained. Certain alternatives within the chosen analytical procedure can produce marked changes in results, for example in cluster analysis by varying the choice of fusion strategy (Grigal and Goldstein, 1972). However, problems relating to choice of analytical procedure are outside the scope of this paper. The following discussion concerns problems relating to the form of the data that are likely to cause distortions in the results, whatever the method of analysis.

THE PROBLEM OF IMPORTANCE VALUES

Whichever method is used to analyse the data matrix the assumption is made that the values therein accurately reflect the ecological importance of the species. The first question to answer, therefore, is which measure or combination of measures of the vegetation truly represents the importance of the species?

The answer lies in the aims of the study, and until some definitive work allows for an objective selection, the choice of measure must remain a pragmatic one (Goff and Cottom, 1967; Moore *et al.*, 1970) based on the requirement that it will supply the information about the vegetation that is needed to meet the aims of the study.

More than one measure may be needed to adequately represent the species, although the use of such composite measures has been opposed (Langford and Buell, 1969) on the basis that they can conceal significant interstand differences, for example where two species have inverse relationships with respect to density and basal area. But in such a case several questions arise. Are 20 bigger trees equal in importance to 40 smaller trees? And if not, is it density or basal area which reflects more closely the ecological significance of the species? Austin and Greig-Smith (1968) have demonstrated how the first ordination axis from an analysis of tropical rain forest data changes according to whether density or basal area is used to represent the species. Without recourse to an objective selection of one or the other measures it is generally better, for example, to weight in some way the density value by the size of individuals, than to use density alone while knowing full well that the individuals are of different sizes. Perhaps an appropriate general importance value for most phytosociological studies would be biomass or some kind of functional value, such as the amount of CO₂ fixed per day by each species, (Whittaker, 1965). But for studies where succession or stage of development is of particular interest (reflected in size of individuals?) it may not be so useful. Being restricted to the characters that can be measured in practice, it may be that certain species are best represented by density, whereas for others (e.g. a rhizomatous grass species) density may have little meaning. Since both kinds of species have to be included in the analysis, they may require different measures, and their comparison is therefore complicated even further. Only if the data are to be subsequently standardized will the direct use of different measures for different species be valid. If the species are to retain their differences in variance, the units used for the two measures must be scaled to the same order of magnitude. The relative pros and cons of standardization are discussed later.

Lambert and Dale (1964) have recommended the use of presence and absence data only, thereby eliminating problems of importance values. In certain types of broad studies where species variation is high and a large number of stands is required, this may be the best approach. In such cases the use of quantitative estimates may not add significantly to the ecological interpretation obtained by analysis of the presence and absence data. However, the possibility of distortion through a chance presence or absence will always remain a danger with this approach, and the objectivity of the method may have to be sacrificed for common sense, to correct blatant anomalies (Moore *et al.*, 1970; Walker

and Coupland, 1970). Where the species of particular interest occur in most of the stands, the information contained in their differences of abundance in the stands cannot be ignored. Two species may occur in all stands and yet exhibit a negative correlation as a result of opposite trends in abundance.

THE PRESENCE OF ZERO VALUES

The allocation of a zero to those species in a study that do not occur in a particular stand is to imply that these species have an equal probability (zero) of occurring in that stand. Since this is not true, to ignore the fact is ecologically more wrong (albeit more objective) than to substitute other values, generated from the remainder of the data, that indicate the degree of absence of these species (Swan, 1970).

If the raw data matrix contains few zero values the substituted values will be well defined. They are determined by averaging the association of absent species with those that are present in the stand, and with few zero values the new values are averages of many measured associations. However, since only a small percentage of the values are changed the effect of the transformation is not very great. As the number of zero's increases so the need for, and effect of, transformation increases, but the reliability of the substituted values de-

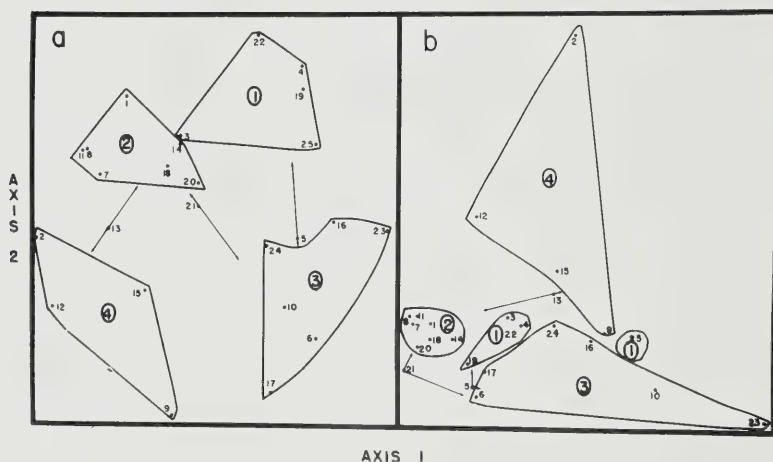


FIG. 1.

First two axes of an ordination by principal component analysis of 25 stands of herbaceous vegetation from southwestern Rhodesia. (a) Following zero-transformation, (b) using the raw data matrix. The data consist of the frequency distribution of 73 species in each stand. See text for explanation.

creases. Figures 1 and 2 demonstrate the effects of zero-transformation on an ordination by principal component analysis, and on a cluster analysis of a set of data from the Kalahari sand deposits in south-western Rhodesia. The data consist of frequency measures of 73 common herbaceous species in 25 stands, using 75 quadrats per stand. They are used only to demonstrate the effects of zero-transformation. The number of stands is insufficient for a full interpretation of the ecology of the region. The ordination procedure is that described by Walker and Wehrhahn (1971). The cluster analysis is an agglomerative, weighted pair group method based on a matrix of inter-stand correlation coefficients.

The four groups of stands depicted in Fig. 1 are as follows: (1) developed woodlands, relatively undisturbed, on deep, infertile sands; (2) scrubby (disturbed?) areas on the same site-types as 1; (3) soils with higher fertility, higher silt contents and often with a restricted rooting zone; (4) sites with a high water table, mostly treeless. Stands 13, 21 and 5 are intermediate with respect to site type, as indicated by the arrows. The first component represents a gradient from treeless stands through to the herbaceous layer that develops under woodland. The second is from deep sand sites (stands 22, 4) to those restricted in depth by either a hard layer that forms a barrier to roots (stands 6 and 17), or by a high water table (all of group 4). The pattern is much clearer in Fig. 1a, following zero-transformation. Fig 1b is apparently evincing the kind of distorted gradients described by Swan (1970).

With respect to the cluster analyses (Fig. 2), levels of correlation are higher using raw data, but zero-transformation has given more ecologically informative results. It has distinguished groups 3 and 4 (as described in the ordination analysis) from the combined groups 1 and 2, with stand 4 being apparently misplaced. It has therefore separated out the three different site types, but has left together the scrubby and developed forms of vegetation on deep, infertile sands. Cluster analysis of the raw data (Fig. 2b) has distinguished between the latter two groups but has failed to separate out the different site types, although group 4 can be recognised to some extent. The two analyses have emphasized different aspects of the vegetation, and each is valid. The use of zero-transformation results in a data set which is more continuous and therefore produces less sharply defined boundaries between groups, and it increases the emphasis in differences or similarities that exist in species with limited abundance. The groups produced by analysis of the raw data reflect differences and similarities in only the dominant and more abundant species. The effects of zero-transformation in cluster analysis will depend on the clustering strategy, and will be less marked if the technique disregards matched zero's.

In contrast to the above, cluster analyses of 44 stands of woody vegetation in the Harvard Forest, Massachusetts (Figs. 3a and 3b), showed the raw data

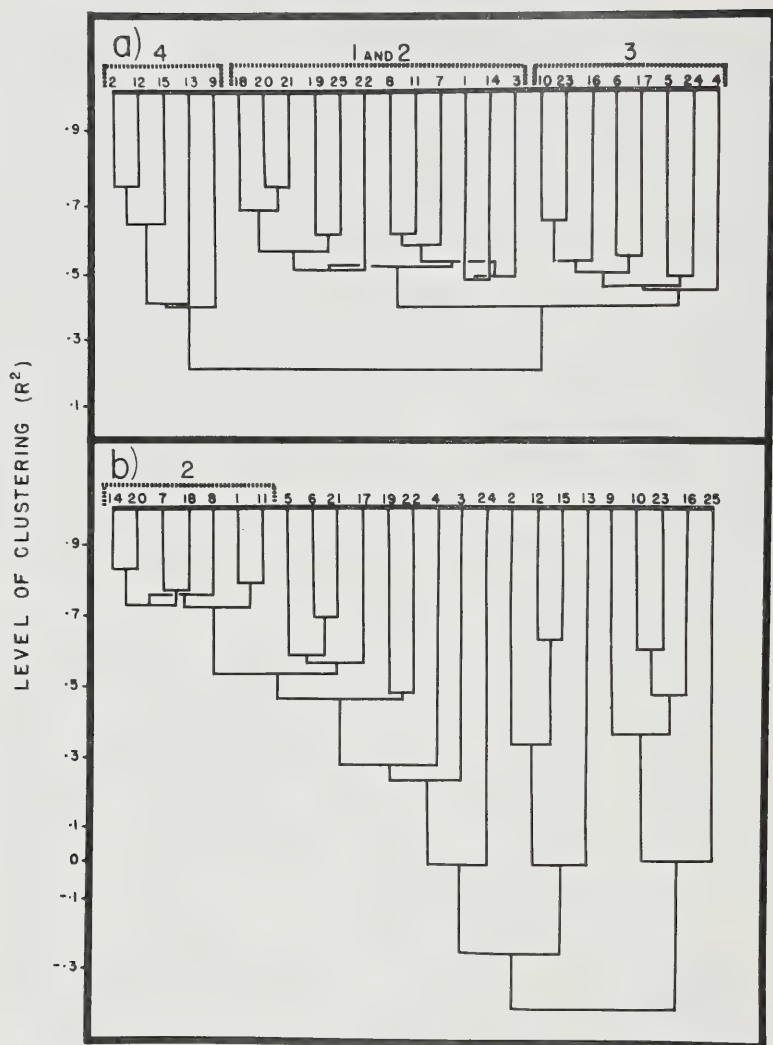


FIG. 2.

Cluster analysis of the same data used in Fig. 1. (a) Following zero-transformation, (b) using the raw data matrix. An agglomerative, weighted pair-group method is used, based on a matrix of inter-stand correlation coefficients.

to be more informative than zero-transformed data. The former separated out six community-types—namely hemlock (1), red maple swale (2), mixed red oak (3), hickory, (4), white pine (5) and black spruce (6), while analysis of the zero-transformed data led to groups 2, 3, and 4 being combined, and more stands being unplaced.

One possible drawback of zero transformation that has emerged from the above studies is that it tends to increase the variance of species with a high proportion of zero's, such that these species may contribute more to the total variance than the more abundant species.

STANDARDIZATION

Standardization of a raw data matrix is performed in order to make the variables comparable. For example, if two variables in the data are pH (measured in units of 1–14) and soil depth (varying perhaps from 20 to 500 cm) they cannot be compared in their original units in the same analysis. If, as in most analyses, the procedure involves successive reductions of variance by one means or another, the variables with the highest measures of variance will in general dominate the results. To make pH and soil depth comparable they should be expressed in the same units. There are various ways in which this can be done, and the most comprehensive account of the methods as they apply to ecological data is given by Austin and Greig-Smith (1968), who describe eight different techniques, including one which involves a zero-transformation.

The most common method is to divide the value of each variable in a stand by the standard deviation of that variable in the study as a whole. It is a conventional procedure adopted in most computer package programmes and it is implicit in any component analysis which is based on a species correlation coefficient matrix, since the correlation coefficient is a standardized measure of covariance. But with ecological data it can distort the outcome of the results, because the influence of all variables is made equal, and the contribution of the lesser species to the total variance is therefore increased. These species generally occur in only a few stands in small amounts and, while it may be that some of them are valuable indicators, they are mostly undersampled variables with little information.

If the data contain one or a few species with particularly high variances, standardization can have a significant adverse effect because the influence of these important species may be so diminished that the gradients they represent are merged with others which have little ecological meaning. But if most species are well represented, standardization will not have drastic, adverse effects. The Rhodesian data discussed earlier fall into this category, and a principal component analysis following standardization of the data that gave rise to Fig. 1a produced an almost identical configuration of the first two axes. Austin and



FIG. 3.

Cluster analysis of 44 stands of woody vegetation in the Harvard Forest, Massachusetts. (a) Using the raw data matrix, (b) following zero-transformation. The data consist of cover/abundance values for 23 species in each stand. The method of clustering is the same as for Figure 2.

Greig-Smith (1968) have concluded that, in general, standardization is desirable in species to avoid the abundance gradient which occurs with unstandardized data, and that the particular form of standardization only becomes important when there are numerous rare species.

If the importance value given to a species is its frequency of occurrence in a number of quadrats placed in a stand, then the resulting data set has values which vary between 0 and 100. The range of most species is comparable, and, subject to the drawbacks of unstandardized data just described, the data can be analyzed in their absolute form. But in some cases, for example where weighted importance values are created by combining estimates of basal area and height, the values may vary from 1 to over 1 000, and in this case a species whose maximum value is less than a hundred will have little influence on the analysis, even though it may occur in a high percentage of stands. In such a case the first, and sometimes second, gradient that appears in a component analysis is merely a reflection of the relative abundances of the species, and can be considered as no more than an abundance gradient. In discriminant function analysis, the opposite effect is obtained with respect to the values of the latent vectors (Hope, 1968). Table 1 gives the percentage contribution to the total variance of 35 woody species in 23 of the stands from Rhodesia (described earlier), using importance values of height in m \times basal diameter in m. Intuitively, these values adequately represent the importances of the species, but in a multivariate analysis *Baikiaea plurijuga* and *Acacia giraffae* completely overshadow the influence of all the other species. Greig-Smith (1971b) obtained similar results from an ordination of data from tropical rain forests in the Solomon Islands. Two means of overcoming the problem, without resorting to standardization by equal variance, are as follows.

The data for each species can be adjusted to vary between 0 and 1, by dividing each value by the highest value for that species. Column (c) in Table 1 shows the effect of this on the same data used above. The situation is improved, but certain species such as *Commiphora africana* are now weighted in importance beyond their contribution to the total variance, even more so than in the case of standardization by equal variance.

The other approach is to transform the data logarithmically. Column (b) in Table 1 shows the effects of this on the same set of data as before, and in this particular instance it was, overall, the best solution, giving rise to the clearest interpretation of the results of a principal component analysis. It is of significance that although the raw data led to meaningless ordinations, the same interpretation was obtained by all three methods of standardization, but with differing degrees of clarity.

The use of a log. transform may not always have a desirable effect, especially if it follows zero-transformation. As described previously, the latter tends to

TABLE 1

Percentage contributions to the total variance of importance values of 35 woody species in 23 stands in the Wankie National Park, Rhodesia. (a) raw data, (b) log. of raw data, (c) data for each species transformed to the range of 0-1.

<i>Species</i>	(a)	(b)	(c)
<i>Acacia ataxacantha</i>	0,8	4,0	1,8
<i>A. fleckii</i>	0,3	1,0	1,4
<i>A. giraffae</i>	30,6	4,6	2,0
<i>A. tortilis</i>	3,1	6,9	1,9
<i>Allophyllus rhodesicum</i>	0,1	3,8	3,8
<i>Baikiaea plurijuga</i>	35,5	6,0	3,6
<i>Baphia massaiensis</i>	1,1	0,7	1,6
<i>Bauhinia macrantha</i>	1,3	1,0	1,3
<i>Burkea africana</i>	0,4	3,1	2,5
<i>Combretum celastroides</i>	0,1	4,5	3,0
<i>C. collinum</i>	0,0	1,2	3,1
<i>C. hereroense</i>	9,3	4,4	1,6
<i>C. zeyheri</i>	0,1	0,7	1,5
<i>Commiphora africana</i>	0,0	2,5	4,5
<i>C. angolensis</i>	0,0	2,2	4,2
<i>C. mozambicensis</i>	0,1	3,1	2,6
<i>C. pyracanthoides</i>	0,0	3,0	4,4
<i>Croton gratissimus</i>	0,1	3,8	3,4
<i>C. pseudopulchellus</i>	0,6	2,8	2,1
<i>Dalbergia melanoxylon</i>	0,0	2,9	4,2
<i>Dichrostachys cinerea</i>	8,5	1,9	1,4
<i>Diospyros lyciodes</i>	0,0	3,8	4,6
<i>D. mespiliformis</i>	0,0	4,0	2,7
<i>Diplorhynchus condylocarpon</i>	0,0	2,1	4,0
<i>Erythrophleum africanum</i>	0,0	2,8	4,3
<i>Grewia flavesces</i>	0,0	0,7	1,7
<i>G. monticola</i>	0,1	1,7	4,0
<i>Guibortia coleosperma</i>	0,0	4,4	1,7
<i>Lonchocarpus nelsii</i>	2,6	1,6	1,9
<i>Ochna pulchra</i>	3,4	1,3	2,2
<i>Pseudolachnostylis maprouneifolia</i>	0,1	4,1	4,4
<i>Rhus tenuinervis</i>	0,0	2,3	3,8
<i>Terminalia sericea</i>	1,3	1,4	2,1
<i>Markhamia acuminata</i>	0,3	4,6	2,2
<i>Pterocarpus angolensis</i>	0,0	3,3	4,7

increase the relative contribution of less abundant species to the total variance. If followed by log. transform, the contributions of these usually under-sampled species becomes so high that they may dominate the analysis.

In summary, the use of unstandardized data, even if zero-transformed, may lead to meaningless abundance gradients. The type of standardization should be such that the rare, less informative species do not play a disproportionately large role in the analysis. Where the range of species values is large a log. transform may be most suitable, as it removes the effects of dominant species but maintains the relative order of importance. The use of a logarithmic transform in plant ecology has been suggested previously by Whittaker (1965). This type of effect can also be achieved by various power transformations, and it may be difficult to determine the optimum transformation procedure.

THE USE OF RELATIVE VALUES

In this procedure the value for a species in a stand is divided by the sum of the values for all species in that stand. The sum of the transformed values in each stand then equals unity. Some authors (Bray and Curtis, 1957; Ayyad and Dix, 1964) believe that relative values offer the best basis for making comparisons between stands, but others (Seal, 1964; Goodall, 1970) believe that the use of absolute values is biologically more meaningful.

Care is initially taken to estimate an importance value which reflects the ecological significance of the species. Values of, say, 100 and 50 for a particular species in two stands are accepted as indicating that the species is ecologically twice as important in the first stand as it is in the second. If relative values are used, the proportions are changed according to the total value of all the other species. Therefore, except where the percentage contribution of each species to a particular stand is of prime importance, absolute values are biologically more meaningful than relative values.

Where environmental measures are included in the analysis, high absolute values for a species in particular stands, corresponding with high values of an environmental factor, may be so reduced by conversion to relative values, as opposed to minor reductions in this species in other stands where there are fewer species, that the correlation between the species and the environmental factor may be obscured.

NON-LINEAR DISTORTIONS

Austin and Noy-meir (1971) and Austin (1972) have discussed the problems of applying linear techniques to data from species with bell-shaped (and therefore non-linear) distributions along environmental gradients, and have demonstrated, with artificial data, the distortions that result. Transform functions exist which can be used to make the data approximate linearity. The difficulty is that in order to know which constants to substitute in the transform equations for each species, one needs some initial idea of the shape of the non-linearity. Generalized non-linear transform functions are needed, and once they have been developed they will no doubt form a basic, initial step for multivariate analyses of most ecological data.

However, untransformed data sets need not necessarily lead to invalid results. In some instances the dominant species in a study do not, in fact, exhibit bell-shaped distributions along major environmental gradients. Two factors can be responsible for this. Firstly, the limits of the study area may exclude one half of the bi-directional curve for many species, although Austin and Noy-Meir (1971) showed that increasing the number of species with such curves decreased distortion only slightly. Secondly, even considering their full range, not all species have bell-shaped distributions. For example, on the

Kalahari sand deposits in Rhodesia the abundance of the dominant tree species (*Baikiaea plurijuga*) increases with increasing sand depth to some as yet undefined level, beyond which it remains at a maximum and does not decrease again to complete the bell-shaped curve. Although admittedly still non-linear, if the number of important species of these two types is large, then the distortions that result will be considerably less than those in the artificial data sets of Swan (1970) and Austin and Noy-Meir (1971).

At this stage in the development of the methods it is important for users of methods that involve ordinations based on Euclidean measures, to be aware of the distortions that can result. Ordination is best suited to the analysis of a comparatively narrow range of vegetation types, and as the range increases so does the amount of distortion due to non-linearity of the species data.

CONCLUSIONS

Consideration of the preceding sections leads to the conclusion that several independent transformations of a set of ecological data are desirable. It is perhaps futile to search for a "best" transformation procedure, when each has particular advantages. Some will result in the analysis being largely influenced by the dominant species and others will emphasize the minor species, each to varying degrees, while still others will place equal importance on all species. More than one transformation may be needed if maximum information is to be gained from a particular procedure.

In relation to the costs of the remainder of the study it is generally worthwhile to perform, or have performed, more than one kind of analysis on more than one transformation of the data, and to compare and combine the information obtained from each.

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STAPELIEAE (ASCLEPIADACEAE) FROM SOUTH TROPICAL AFRICA: 8

L. C. LEACH

ABSTRACT

A new species of *Trichocaulon* N. E. Br. from Angola is described as well as a new variety of *Huernia verekeri* Stent from the western escarpment of the Serra de Chela in Angola. The distribution of this latter species, as now known, extends from the shores of the Indian Ocean almost to the Atlantic coast of Angola. The generic distinctions between *Duvalia* and *Huernia* are discussed and further, more detailed evidence is presented in support of three recent transfers from *Duvalia* to *Huernia*.

UITTREKSEL

STAPELIEAE (ASCLEPIADACEAE) VAN SUIDELIKE TROPIESE AFRIKA

'n Nuwe *Trichocaulon* N. E. Br. soort vanaf Angola en 'n nuwe *Huernia verekeri* Stent vanaf die westelike plato-rand van die Serra da Chela in Angola word beskryf. Die verspreiding van laasgenoemde soort, soos tans bekend, strek van die Indiese Oseaan kus tot byna aan die Atlantiese kus van Angola. Die verskille tussen die geslagte *Duvalia* en *Huernia* word bespreek en meer bewyse word aangebied ter staving van drie nuwe oorplasinge van *Duvalia* na *Huernia*.

Trichocaulon mossamedense Leach, sp. nov.

T. pedicellato Schinz arcte affinis sed planta grandissima, robustissima, caulibusque crassioribus spinosioribus; pedicellis longioribus; corolla minus profunde lobata, tubo 2-plo longiore; corona profundius cupuliformi, lobis exterioribus emarginatis (vix bifidis), lobis interioribus antherisque in cupula coronae paene inclusis, essentialiter differt.

Planta succulenta spinosa, erecta, usque 30 cm alta, caulibus 1-4, plerumque c. 20 cm longis, 4-5 cm diam., prominenter 16-20 angulatis; angulis compressis tuberculatis; tuberculis conicis compressis, 4-7 mm altis, secus angulos confluentibus, omnibus spina valida, brunnea, usque 6 mm longa munitis. *Flores* tuberculi apice deinceps prodientes, plerumque caulis apicem versus; pedicellorum reliquiis persistentibus pedunculum brevem crassum, nodosum, more *Huerniae urceolatae* Leach, gradatim formantibus. *Bractee* glabrae, anguste deltatae, c. 1 mm longae. *Pedicelli* glabri, 10-15 (18) mm longi, c. 1 mm diam. *Sepala* deltata, acuminata, subtus obtusa, 2,5-3,0 mm longa, c. 1 mm lata basibus paululum imbricatis, dentibus carnosius parvis interdum intus sepalis alternantibus. *Corolla* rotata, c. (9) 12 mm (*Mendes* 3845, 19 mm) inter apices lorum alternorum, marronina, saepe intense atro-marronina extus glabra, intus minutissime papillosa, pilis brevissimis, plerumque acutis, sub-appressis, vestita; *tubo* c. 1,5 mm longo; *corollae lobis* ovatis, acuminatis, c. 4 mm longis,

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basi 3,5 mm latis, plerumque leviter convexus. *Corona* glabra, atro-marronina, fere nigrescens, cupuliformis sed tantum 1,5 mm profunda, c. 3,5 mm diam.; lobis exterioribus c. 0,75 mm longis, 2 mm latis, latissime emarginatis; lobis interioribus anguste oblongis, obtusis, antheras subaequantibus arcte incumbentibusque; *pollinia* flava, c. 0,35 mm longa, plus minusve ovoidea aliquanto compressa, margine interiore recto. *Folliculi* fusiformes aliquanto compressi, aliquam divergentes, leviter incurvi, satis laeves.

Typus: ANGOLA, Moçâmedes Distr., Leach & Cannell 14690 (LISC, holo; SRGH).

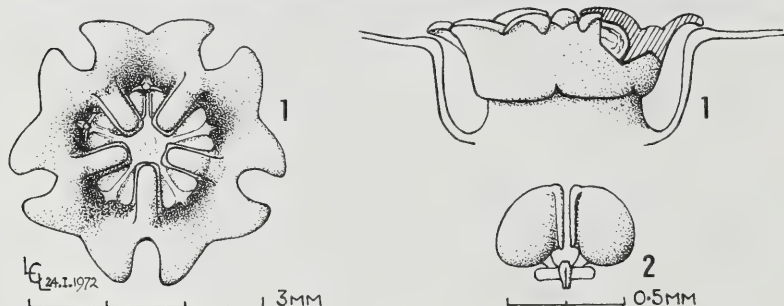


FIG. 1.

ANGOLA. Moçâmedes Distr., ± 21 km N of Chapeu Armado, in association with several euphorbias and other succulents, at foot of rocky ridge, fl. 1.xi.1970, Leach & Cannell 14697 (K; M); ± 20 km on Lucira road, in association with numerous succulents, fl. 1.xi.1970, Leach & Cannell 14692 (BOL; LUAI); ± 10 km on Lucira road, on hillside among red rocks with *Euphorbia carunculifera* Leach, *Cissus* spp. etc., fl. 31.x.1970, Leach & Cannell 14690 (LISC; SRGH); ± 30 km N of Moçâmedes, cult. Johannesburg, fl. Sept. 1971, Horwood, Downes & Chambers sub Lavranos 9745 (PRE); ± 45 km de Moçâmedes para Dois Irmãos, fl. 28.iv.1960, Mendes 3845 (LISC).

This new species from Angola appears to be most closely related to *T. pedicellatum* Schinz but is a larger, more robust, erect plant with spinier, stouter stems, while the flowers with their less deeply lobed corolla and much deeper tube are borne on considerably longer pedicels; the corona is essentially different in that it is so much more deeply cupped with the anthers and the incumbent inner lobes almost or quite included, and the shallowly emarginate outer lobes are quite unlike the deeply bifid lobes of its relative.

It seemed at first that these Angolan plants might represent only a further variation of the extremely variable *T. pedicellatum*, but it is considered that the nature and extent of the distinguishing characteristics displayed by them,

particularly those of the corona, clearly establishes their distinctness at specific level.

T. mossamedense is possibly the most common stapeliad in Angola and although the existing records show its distribution to be restricted to Moçâmedes District it is believed that a plant collected from a rocky hillside near Dombe



FIG. 2.

Trichocaulon mossamedense Leach. Plant collected 30 km N of Moçâmedes by Messrs. Horwood, Downes & Chambers; flowering in Johannesburg. Photo Mr. J. Lavranos.

Grande, in Benguela District, may well represent this species; however, this specimen unfortunately died before flowering.

It is rather surprising therefore that until very recently the species appears to have been collected only once and then not until 1960. One wonders if the more recent gatherings have been due to a periodic population build up, such as has been observed elsewhere among some other species of the tribe; and if so whether this will also be followed by a rapid decline in numbers.

Plant succulent, spiny, erect, up to ± 30 cm high; *stems* 1–4, usually ± 20 cm long, 4–5 cm diam. with 16–20 prominent, tuberculate angles; *tubercles* compressed conical, confluent along the angles, 4–7 mm high, each tipped with a strong, brown spine up to 6 mm long. *Flowers* developed successively from a tubercle apex, usually towards the apex of the stem, the persistent pedicel bases gradually forming a knobby stump-like peduncle, similar to but shorter than that of the geographically associated *Huernia urceolata* Leach. *Bracts* glabrous, narrowly deltate, ± 1 mm long. *Pedicels* glabrous, 10–15(18) mm long (lengthening in fruit) ± 1 mm diam. *Sepals* deltate, acuminate, obtuse beneath, 2.5–3 mm long, ± 1 mm wide at the very slightly overlapping bases, with or without a small subulate fleshy tooth alternating with the sepals inside. *Corolla* rotate (occasionally shallowly campanulate or rarely, somewhat reflexed) $\pm (9)12$ mm (*Mendes* 3845 18 mm) across the apices of alternate lobes, with a tube ± 1.5 mm long, often with a slight annulus around its mouth, pale to dark, almost blackish, maroon, glabrous outside, microscopically papillate and covered within with more or less appressed, very short, mostly acute hairs; *lobes* ovate acuminate, ± 4 mm long, 3.5 mm wide at the base, usually slightly convex. *Corona* glabrous, dark maroon almost black, shallowly cup-shaped, ± 1.5 mm deep, 3.5 mm diam. with the outer lobes spreading, ± 0.75 mm long, 2 mm broad, shallowly broadly emarginate; with the inner lobes narrowly oblong, obtuse, closely incumbent on and subequalling the anthers, with a small hump at the base where adnate to the outer lobes. *Pollinia* \pm compressed ovoid with the inner margin straight, ± 0.35 mm long, yellow attached to the dark brown, shortly winged carrier by short broad caudicles. *Follicles* (not fully developed) somewhat compressed fusiform, divergent, slightly incurved, quite smooth.

Huernia verekeri Stent in Kew Bull. 1933: 145 (1933).—Phillips, Flow. Pl. S. Afr. 15: t.591 (1935).—White & Sloane, Stap. 3: 848 (1937).—Luckhoff, Stap. S. Afr.: 199 (1952).—Jacobsen, Handb. Succ. Pl. 2: 630 (1960) et Sukk. Lexik.: 245 (1970).—Huber, Asclepiadaceae, Prodr. Fl. S.W. Afr. 114: 38 (1967).—Leach in Bothalia 10(1): 48 (1969).

Since the publication of var. *pauciflora* Leach (*Bothalia l.c.*) a third variety has been discovered in Angola. The distribution of this species is therefore now

known to extend from the shores of the Indian Ocean, near the mouth of the Save River in Moçambique, almost to the Atlantic.

Var. **angolensis** Leach, var. nov.

A varietate typica caulibus aliquanto decumbentibus obtuse angulatis, illis varietatis typicae maxime differentibus; corollae tubo fere omnino saturate rubro coroneaque rubella facile distinguenda.

Typus: ANGOLA, Huila Distr., Serra da Chela, *Leach & Cannell 14650* (BM; LISC, holo.; LUAI; PRE; SRGH).



FIG. 3.
Huernia verekeri var. *angolensis* Leach & Cannell 14650

Chromosome number: $2x = 22$. Count by the late Prof. Dr. G. Reese, Botanischen Institut der Universität Kiel (personal comm.).

ANGOLA: Huila District, on the western escarpment of the Serra da Chela, west of Tchivinguiro, cult. Greendale, Rhodesia, fl. Nov. 1971, *Leach & Cannell 14650* (BM; LISC; LUAI; PRE; SRGH).

Plants were found growing in a damp situation on rock ledges of cliffs above Bruco, on the western escarpment of the Serra da Chela. Although not flowering when collected, the appearance of the stems and their habitat convinced us that here was merely another record of *H. volkartii* Werderm. & Peitsch, which was known to occur only a few miles away. Fortunately, in accordance with our usual procedure, a few stems were collected for cultivation and the preparation of herbarium material, if and when flowers should be produced; in the event these obviously, but most surprisingly, belonged in *H. verekeri*.

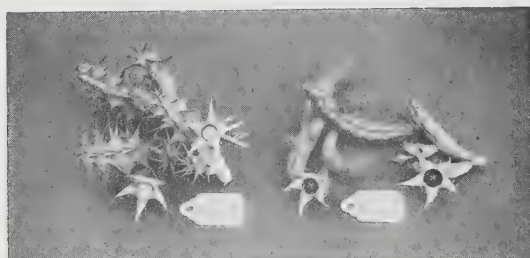


FIG. 4.
Huernia verekeri: a comparison: Left: var. *verekeri*. Right: var. *angolensis*.

Perhaps the most striking feature of the new taxon is the bright red of the corolla tube, with the colour extending almost to its base, which, together with the reddish corona, gives the flowers an appearance so very different from that of those of the typical variety. However, it is in the stems that the really significant difference is found; these, in addition to lacking the strongly toothed angles so typical of var. *verekeri*, adopt a somewhat decumbent habit which is very different from that of the erect caespitose plants of the typical variety.

Varietal rank has been considered appropriate for more or less the same reasons as prompted its use for var. *pauciflora*. As in that variety, only one population has been found, and although this was fairly extensive it is thought that it could easily have arisen from clonal division. Although the divergence in vegetative characters is considerable, this should be viewed against the background of stem variation which occurs in such species as *H. pillansii* N.E. Br. and *H. volkartii* when assessing its relative importance. However, should these characters subsequently be found to be more or less constant throughout its distribution, possibly along the western escarpment of the Serra da Chela, then, considered in conjunction with its quite different ecology, a change in status would most probably be justified.

Huernia andreaeana (Rauh) Leach in *Bothalia* **10**(1):54(1969).

When making this combination the basionym was cited as: "*Duvalia andreaeana* Rauh, l.c. (1961)."

As "l.c." is not strictly in accordance with the requirements of the International Code of Botanical Nomenclature, Article 33 (1966), relating to valid publication, a more explicit reference is given below.

Huernia andreaeana (Rauh) Leach, comb. nov.

Duvalia andreaeana Rauh in *Kakteen u. andere Sukkelenten* **12**:117(1961).

I am much indebted to Mr. J. B. Gillett for drawing my attention to this oversight.

NOTES ON THE GENERIC DISTINCTIONS BETWEEN *DUVALIA* HAW. AND *HUERNIA* R. BR.

Whilst dealing with the foregoing combination it seems opportune to refer to Dr. R. A. Dyer's note in *Bothalia* **10**(2):363-365(1971), in which he suggests that the three new combinations made in *Huernia*: namely, *H. tanganyikensis* (Bruce & Bally) Leach; *H. procumbens* (R. A. Dyer) Leach and *H. andreaeana* (Rauh) Leach, should revert to *Duvalia*. I have again examined the available material and gone over the arguments on which I based these new combinations and find no reason to change my opinion; in fact rather the reverse. However, Dr. Dyer's article appears to me to raise issues of sufficient importance in relation to the generic classification of *Stapelieae* to warrant the detailed discussion which now follows, and for the unavoidable length of which I must apologise to my readers.

In basing his opinion regarding generic placing mainly on the shape and possible evolutionary development of a single character (the dorsal development of the inner coronal lobes) Dyer appears to ignore other characters and their significant *correlations*.

So-called generically "essential" or "exclusive" characters appear so frequently in widely separated species (e.g. "Echidnopsis stems" in *Huernia pillansii* N.E.Br. subsp. *echidnopsioides* Leach) or may be absent in otherwise obviously correctly placed species (e.g. the lack of tube in *H. marnieriana* Lavr.) that one is compelled to rely on correlations of characters rather than on the presence or absence of any one of them.

It is in this connection that Dyer makes great play with "sometimes" in relation to the few exceptions listed in my original article. He states that I have excluded the three controversial species from *Duvalia* because: their coronas are not stipitate; their stem teeth devoid of denticles and their corolla lobes neither replicate nor ciliate (which is correct); but goes on to say that I have allowed other species lacking these characters to remain in *Duvalia* (which

is both incorrect and misleading). Incorrect insofar as the stipitate corona is concerned (Dr. Dyer himself suggests only a possibility of an exception, in *D. maculata* N.E.Br., of which more anon); misleading in the implied correlation of these absences in single species, whereas they were cited only as uncorrelated single exceptions (save for two in *D. sulcata*, and even here the corolla lobes although not replicate are convex) and are restricted to species which are otherwise indubitably *Duvalia*, while absence of cilia (the most frequent exception) may, in some species, be due merely to the loss of these fragile hairs from the available material. However, it should be noted that all four characters are absent from each and every one of the three disputed species and, which is more important, there are no known exceptions whatever for the corresponding positive characters in *Huernia* (the three erstwhile *Duvalia* spp. included).

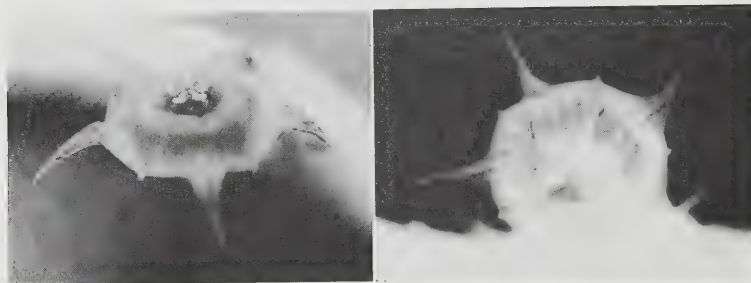


FIG. 5.
Huernia tanganyikensis showing small but distinct intermediate lobes and canaliculate corolla lobes.

Against this correlation of four definite characters Dyer sets as conclusive: the apparent evolutionary development of the dorsal projection of the inner coronal lobes, drawing an arbitrary line between *H. verekeri* and his *D. procumbens*, which not only implies acceptance of "in line" evolution (which I consider doubtful in relation to *Huernia-Duvalia*) but is determined by the degree of enlargement and extent of upturning of this portion of the coronal lobe. He also draws attention to the 5 small teeth alternating with the corolla lobes in *Huernia*, which were omitted by me as being undiagnostic; this seems to me to be a rather nebulous character, "formed by the projecting sinuses" (N.E. Brown), very variably developed in *Huernia* and intermittently present in most genera of the tribe, albeit extremely small when present in *Duvalia*. In stating that none of the disputed species possesses these intermediate teeth Dyer is again in error (see photos) since they are quite evidently present in *H. tanganyikensis*, while the photo (Abb. 2) of *H. andreaeana* in Kakteen und andere Sukkulente 12: 115 (1961) appears to indicate an even greater develop-

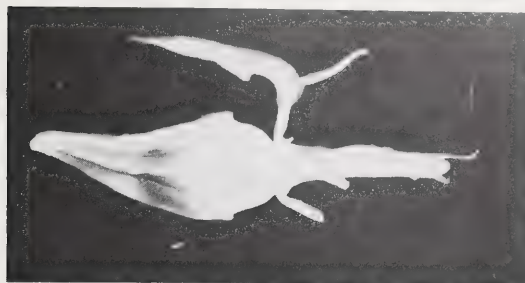


FIG. 6.

Huernia procumbens showing intermediate lobes in bud and above, intermediate lobe concealed by reflexed corolla.

ment of this character in that species. Similar, although very inconspicuous, projecting sinuses are also present in *H. procumbens*; although these are usually concealed by the strongly reflexed corolla they are clearly seen in buds and are, in fact, rather less inconspicuous than those of *H. marnieriana*, which despite its virtual lack of intermediate lobes and almost flat corolla is quite acceptable in *Huernia* on its remaining characters.

Thanks to the efforts of Mr. D. C. H. Plowes I have now been able to examine specimens of *D. maculata* (var. *immaculata* appears to be merely one of the many colour forms) and find that these conform exactly to N. E. Brown's description: "annulus with its sides sloping underneath (not vertical), and the rim rising considerably above the margin of the outer corona", the corona being listed as stipitate in the generic description (see photo.). It seems, therefore, that it is merely the height of the annulus which is exceptional and that the corona is of the stipitate form normal for the genus.

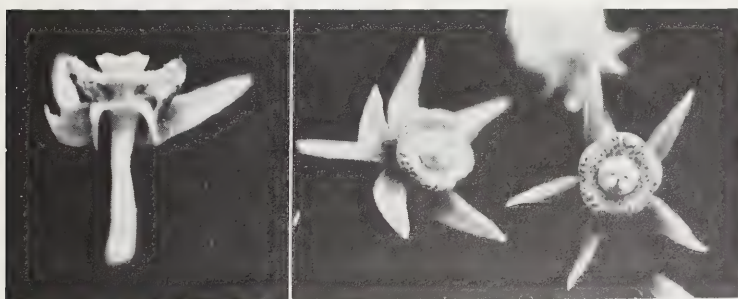


FIG. 7.

Duvalia maculata showing stipitate corona and replicate corolla lobes.

It remains only to examine Dyer's contention that I am in error in saying that my rearrangement requires no amendment to the existing generic circumscription of *Huernia*. In this he is correct only in respect of N. E. Brown's diagnosis of 1909 (for S. African plants), this would need a very slight alteration which could be achieved by the removal of the one word "slight" or the addition of "or enlargement of" in relation to the dorsal ridge of the inner coronal lobes. In fact this amendment has been accepted by implication for many years by the inclusion of such species as *H. schneideriana* Berger (1913) and *H. verekeri* Stent (1933).

What Dyer omits to mention, however, is that the inclusion of "tanganyikensis", "procumbens" and "andreaena" in *Duvalia* requires such a measure of modification to the circumscription of that genus (again taking N. E. Brown's description in Flora Capensis 4) that virtually nothing of significance remains. To be explicit it is necessary to exclude the following:

1. . . . annulus supporting the corona;
2. corona stipitate, resting on the rim or sides of the cup formed by the annulus;
3. corolla lobes replicate;
4. inner corona-lobes \pm pointed at each end;
5. rudimentary leaf with a minute denticle (stipule) on each side at its base; to which could be added: corolla lobes usually ciliate.

Thus leaving only 3 virtually undiagnostic characters as follows:

1. corolla raised into an annulus (common to several genera);
2. outer corona flat, entire, \pm pentagonal or rarely 10-sided;
3. inner corona-lobes turgid, subhorizontal, with the dorsal "point" *usually* somewhat raised and the inner portion not produced into erect points;

which leaves the generic circumscription of *Duvalia* somewhat vague, to say the least, especially as all three characters are to be found in *Huernia*.

In conclusion it appears from the foregoing that it is essential, in the classification of *Stapelieae*, to consider correlations of significant characters, especially in "borderline cases" and that apparent relationships based on single characters or resemblances can often be most misleading.

Any alternative course would seem inevitably to lead either to the recognition of purely arbitrary divisions between the genera or to the merging of several of them, with the attendant, probably numerous, nomenclatural changes. Neither of these, it seems to me, would serve to clarify the position; in fact it seems possible that some clarification might be attainable by slight further division of *Stapelia* and/or *Caralluma*, together with some realignment of a few controversial species. This, however, remains a task for the future, dependent for its solution mainly on the availability of adequate material.

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The late Professor Dr. G. Reese, for permission to publish the chromosome counts of *Huernia verekeri*.

DISCRIMINANT ANALYSIS USED TO DETECT POPULATION VARIATION AMONGST GRASSES COLLECTED ON MINE DUMPS

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ABSTRACT

Quantitative characters are used to show measurable morphological differences between populations of grasses collected from slimes dams and sand dumps of Johannesburg and "natural" populations from other areas. Multivariate discriminant analysis, which considers many characters simultaneously, is used to express numerically the degree of integration between populations as well as variation within each population studied.

UITTREKSEL

DIE GEBRUIK VAN DISKRIMINANTANALISE OM VARIASIE TUSSEN GRASBEVOLKINGS OP MYNHOPE AAN TE TOON.

Kwantitatiewe eienskappe is gebruik om meetbare morfologiese verskille tussen monsters van grasbevolkings op sekere slykdamme en mynhope van Johannesburg en monsters van "natuurlike" bevolkings van ander plekke aan te dui. Multivariaat diskriminantanalise waardeur verskillende kenmerke gelyktydig behandel word is gebruik om die mate van integrasie tussen plantbevolkings sowel as die variasie binne elke bevolking, numeries uit te druk.

INTRODUCTION

The establishment of a vegetative cover on the slimes dams and sand dumps, the waste heaps of Johannesburg and the Reef Mines, not only involves the growing of plants but bringing a plant community into being that will maintain itself (James, 1966).

The material of both slimes dams and sand dumps, the two types of waste dumps created by gold mining operations on the Witwatersrand, is very similar and results from two different extraction processes. Sand dumps are conical heaps with one sloping side (Fig. 1), constituted of finely crushed rock from which the gold is removed by a dry process. This waste material is tipped onto the surface by cocopan. The slimes dams are deposited by pumping a slurry of finely crushed conglomerate onto the surface after the rock has undergone the cyanidization process. Slimes dams are lower in elevation than sand dumps and form square, flat and shallow waste tips (Fig. 1).

The Chamber of Mines established a Vegetation Unit (Fig. 1) whose purpose was to cover the dumps so as to minimise the problem of air and water pollution so prevalent in areas adjacent to the dumps. The first attempts made were those using physical methods; but various plastics, resins and bitumen coatings

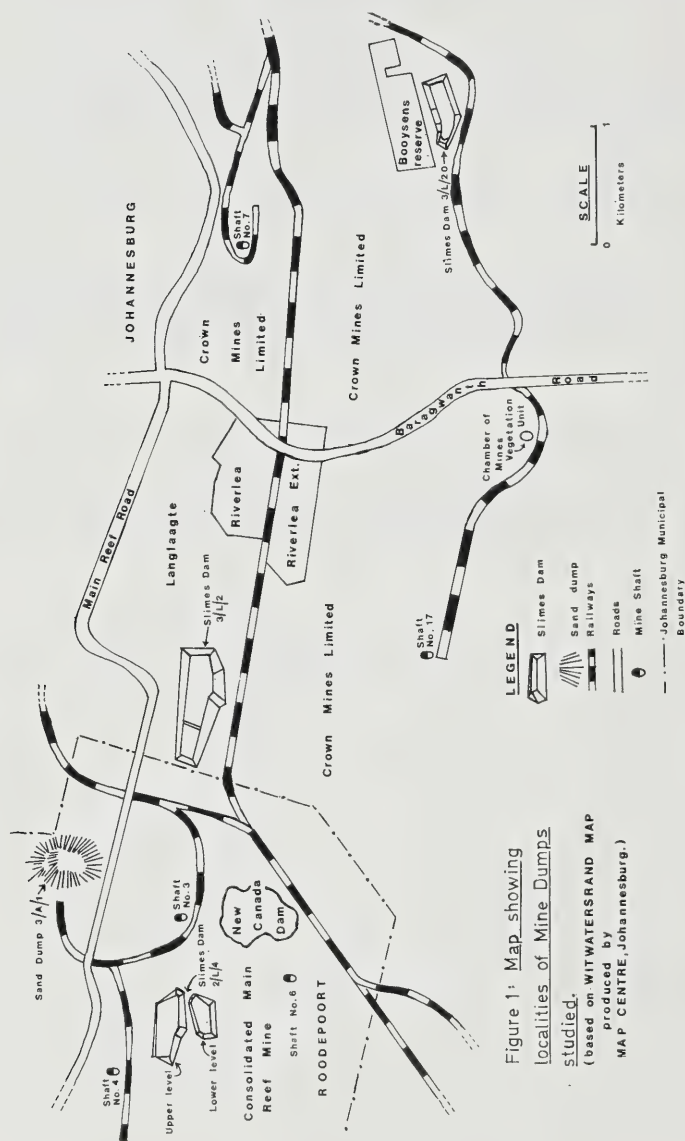


Figure 1: Map showing localities of Mine Dumps studied.
(based on WITWATERSRAND MAP produced by MAP CENTRE, Johannesburg.)

Fig. 1.
Map showing location of Mine Dumps studied.

used proved vulnerable to wind and hail. A cover of stone and soil was tried but this also failed (Cook, 1971). By the end of 1959 it was clear that the best and cheapest method of establishing a permanent cover on the dumps would be to condition the residue to support plant growth (Webster, 1972). This entailed both the correction of very low pH values of the slimes and the extreme acidity resulting from the oxidation of pyrite near the surface. This was followed by selection of plant species, particularly those with slightly acid tolerance ranges and thus suited to this type of environment, for initial plant coverage. A seed mixture containing twenty varieties of Leguminosae and Gramineae was finally used. Chenik (1960, 1963), James and Mrost (1965) and James (1963, 1966) have been the main contributors to research into the establishment of vegetation on the mine dumps.

The present problem is the maintenance of the vegetation cover after initial establishment, as well as the formation of a soil microbial population which will ensure the recycling of essential plant nutrients. The progression towards a more natural grassland and shrub environment is envisaged.

This study, which is more fully presented in Thatcher (1972) has been primarily concerned with populations of indigenous grasses that have been associated with a trend towards greater stability of this artificially created environment.

"In general sense, a population can be defined as an aggregate of individuals considered together because of their common habitation of a given area at a given time" (Heslop-Harrison, 1960). Dobzhansky (1951) defines the population more precisely as a reproductive community of sexual and cross fertilizing individuals which share a common gene pool. Raup and Stanley (1971) point out that within a living population at any time there is variation due to age differences and *at very least*, this is reflected in the differences in size amongst individuals constituting the population.

This study made use of multivariate discriminant analysis to determine whether or not the variation that exists among plants collected from populations on mine dumps differs statistically from that of those plants collected from populations of the same species growing in "natural" areas on the highveld.

MATERIALS

A total of nine arbitrarily chosen indigenous species was used: *Eleusine indica* (L.) Gaertn., *Pogonarthria squarrosa* (Licht.) Pilg., *Setaria flabellata* Stapf, *Chloris virgata* Sw., *Hyparrhenia hirta* (L.) Stapf, *Andropogon eucomus* Nees; and three species that were initially included in the seed mixture planted on the dumps, *Paspalum dilatatum* Poir., *Chloris gayana* Kunth and *Cynodon dactylon* (L.) Pers. Each of these species was collected from a minimum of four areas, at least two of the areas being mine dump localities



FIG. 2 A and B.

A general view of the top of Booyens Reserve, Crown Mines Slimes Dam 3/L/20, showing the vegetation cover, predominantly grasses.



(Fig. 1). The areas were three slimes dams 3/L/20 Booysens Reserve; Crown Mine Slimes Dam (Fig. 2); 2/L/4 (Lower Level) Consolidated Main Reef Slimes Dam (Fig. 3); 3/L/2 Crown Mine Slimes Dam, and a sand dump 3/A/1 Crown Mines Sand Dump (Fig. 4). Collections were also made from the following "natural" environments of the Transvaal; Pilgrims Rest district; Middelburg district; Krugersdorp district; Witkoppen in the Sandton district; and Frankenwald, Greenside and Parkview in the Johannesburg district. A total of forty-three populations were collected during the period 25th February to 9th April, 1971. The results of only *Pogonarthria squarrosa* (Licht.) Pilg., *Cynodon dactylon* (L.) Pers., *Hyparrhenia hirta* (L.) Stapf and *Chloris gayana* Kunth are reported in this paper.



FIG. 3.

A general view of the lower level of 2/L/4 Consolidated Main Reef Slimes Dam, showing its grass cover, with the access road up the side, *Eucalyptus* trees in the foreground.

Twenty "individuals" constituting a culm, a stem terminated by an inflorescence, were cut at ground level from plants chosen at random from each population in the field. Rooting portions of the plant were not considered. All specimens were labelled, pressed and dried, a voucher specimen being deposited in the Moss Herbarium, University of the Witwatersrand.



FIG. 4.
The large Consolidated Main Reef Mine Sand Dump 3/A/1.

CHARACTERS

The selection and recording of characters is perhaps the most crucial issue of a numerical study, as an unsuitable selection of characters can change the entire course of an analysis (Ivimey-Cook, 1968). A character is defined as "any attribute referring to form, structure or behaviour which can occur in any one organism as one of two or more mutually exclusive states" (Kendrick, 1964). Quantitative characters, defined as "any character which can be measured and expressed numerically, (Kendrick, 1964), were used in this study. Characters were chosen in order to represent the maximum amount of genetic variation expressed through the morphological characters of the individuals constituting the population. These characters also showed measurable differences when considering different populations. A total of twenty-two characters was used (Table 1). The number of characters used in a single analysis varied from species to species as some characters did not apply to some of the species. This did not affect the analysis as the nine species were analysed separately. Measurements of real or continuous variables corrected to two decimal places were made on each individual, using a brass rule or a micrometer eyepiece fitted to a binocular microscope. The count data consisting of integer values were transformed using a square root transformation. Data matrices or tables were

then drawn up taking the form of an $n \times t$ matrix (where n represents characters in rows and t represents twenty individuals in columns).

TABLE 1.

List of characters used in discriminant analysis.

NOTE: All measurements in cm.

Total length of culm from first node at the base of culm
Length of first internode at base of culm
Length of leaf sheath
Length of leaf blade
Width of leaf blade just above ligule
Length from last node to first raceme
Length of inflorescence (total)
Length of individual raceme (lowest one)
Length of spikelet excluding awns
Length of palea
Length of floret
Length of anther
Length of lemma awn
Length of palea awn
Length of grain
Width of grain
Arrangement of spikelets on raceme
Number of nodes per culm
Number of racemes
Number of spikelets per raceme
Number of florets in spikelet
Number of awns

NUMERICAL METHOD

Analysis of the data was by discriminant analysis, using a Fortran IV computer programme (DISCR) written by one of us (R.A.L.), based on the Fortran II programme for multivariate discriminant analysis of Davis and Sampson (1966), on an IBM 360/50 computer. The analysis is essentially a statistical technique of assigning samples to previously defined populations on the basis of a number of variables considered simultaneously (Davis and Sampson, 1966). It is of great value in detecting and establishing a criterion for separating populations. "An important advantage of discriminant function lies in its potentiality of application to individuals. While the functions themselves are primarily population concepts, and their derivation demands knowledge of the bulk variation of the two groups or populations involved, an important property of them in use is that they can be made sensitive enough to place single plants accurately in relation to the average of these groups" not on the basis of one, but on a wide range of characters (Heslop-Harrison, 1952).

This technique involves the calculation of discriminant values (R_1 and R_2) for each population sample and a discriminant index R_0 , the dimensional plane which most efficiently separates the clusters of points representing the population. A sample from a third population may be assigned to one or other of the

populations depending on which side of R_0 the discriminant values fall. A test for significance (analysis of variance) may be derived from Mahalanobis Generalized Distance (D^2). The contribution that each variable makes to the total distance is calculated and the importance of each character to the analysis can be assessed.

The technique was originally developed by Fisher (1936) as a solution to a taxonomic problem using multiple measurements. He applied this technique to the flowers of three species of *Iris*, and outlined the mathematical implications of the method. This technique has since been used in many other disciplines including geology (Emery and Griffiths, 1954; Mellon, 1964), paleobiometrics (Miller and Kahn, 1962), and taxonomy (Lefebvre and Lennes, 1969). Blackith and Reyment (1971) provide an outline of case histories, derived from various disciplines which use discriminant functions.

PRESENTATION OF RESULTS

The results are presented as tables of discriminant values (Tables 2-4), polygonal graphs (Figs. 5, 7, 9 and 11) and scatter diagrams (Figs. 6, 8 and 10). The discriminant tables are modelled on the tables of Krumbein and Graybill (1965) and show discriminant values for twenty individuals from three populations in relation to the calculated values of the discriminant index R_0 and the discriminant values R_1 and R_2 for each population compared.

Polygonal graphs are drawn for each species in order to indicate visually the amount of variation between the different populations studied. The polygonal graph (or polygraph) is a method commonly used in population analysis in order to portray several variables simultaneously (Davis and Heywood, 1963). In each polygonal graph, the eight characters adding the greatest percentage to the analysis are positioned on the eight radii in a clockwise manner in decreasing order of importance. The mean values of each character for the twenty individuals of each population were plotted.

Scatter diagrams were plotted to show the relationship between two of the most important characters. Scatter diagrams show the variation in each character and glyphs for the individuals are plotted where the values for each character intersect (Davis and Heywood, 1963).

DISCUSSION

Table 2 shows the discriminant values calculated for three different populations of *Pogonarthria squarrosa*. An *F* value of 77,28 was obtained when the sand dump (3/A/1) and Frankenwald populations were compared and was highly significant at the 0,1% level, the comparison having a D^2 value of 146,84. Here the Krugersdorp population is seen to be an intermediate population as about half of the discriminant values calculated overlap the sand dump values

TABLE 2.
Discriminant values for three populations of *Pogonarthria squarrosa* (Licht.) Pilg. For explanation, see text, p. 33.

3/A/1 Sand Dump Values	Krugersdorp Values ("Natural" Population)	Frankenwald Values ("Natural" Population)
— 62,388 50		
— 87,680 31	— 82,402 82	
— 96,250 43		
— 98,309 51		
— 98,504 01		
— 98,929 78		
— 99,908 23		
— 102,198 52	— 100,189 50	
<i>R1</i> — 103,576 9		
— 104,318 73		
— 105,927 06		
— 106,812 38		
	— 107,706 24	
— 108,516 14		
— 109,174 55		
— 109,216 57		
— 109,574 14		
	— 110,662 92	
— 110,727 48		
— 111,701 08		
— 114,551 65		
— 118,292 48		
— 118,557 63		
	— 124,284 48	
	— 146,970 03	
	— 155,869 34	
	— 173,352 17	
	— 174,730 90	
	<i>R ZERO</i> — 176,995 9	
	— 177,331 30	
	— 178,170 85	
	— 187,262 80	
	— 198,156 40	
	— 200,948 20	
	— 204,290 16	
	— 213,611 69	
	— 214,891 31	
	— 218,383 74	
	— 227,225 71	
	— 229,137 82	
		— 232,965 94
		— 234,938 19
		— 235,028 76
		— 235,486 21
		— 239,606 81
		— 241,913 28
		— 242,378 86
		— 243,680 30
		— 245,052 69
		— 250,376 17
		<i>R2</i> — 250,414 9
		— 252,684 94
		— 256,873 29
		— 257,944 34
		— 258,227 54
		— 258,630 62
		— 259,603 52
		— 262,889 40
		— 262,981 93
		— 263,548 34
		— 273,488 04

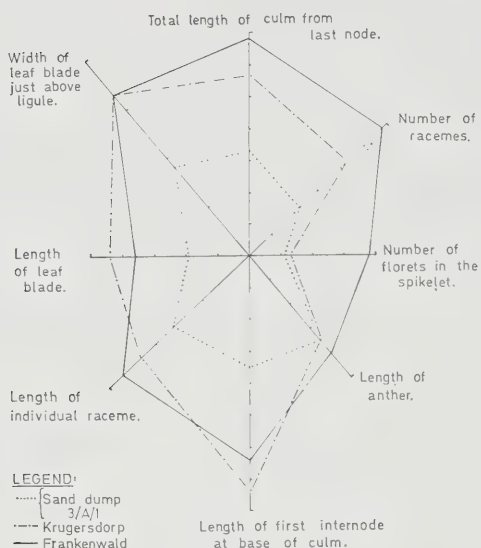


FIG. 5.
Polygonal graph for *Pogonarthria squarrosa* (Licht.) Pilg.

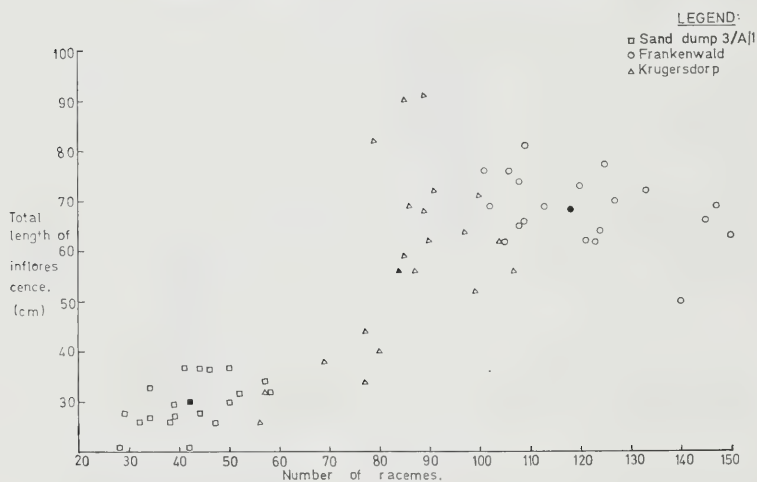


FIG. 6.
Scatter diagram for *Pogonarthria squarrosa* (Licht.) Pilg.

and the other half are found on the Frankenwald side of the discriminant index R_0 , between this and the first discriminant value for Frankenwald. The R_0 value shows the two populations to be distinct, one population falling to the right and one to the left of this plane.

The polygonal graph (Fig. 5) for *Pogonarthria squarrosa* shows the sand dump population to occupy a position nearest to the central point of the radii. The intermediate Krugersdorp population seems to be closer to the sand dump population when looking at some characters and closer to the Frankenwald population when looking at others. The mean values for the most important character, the total length of the culm, substantiates this arrangement. Notice that although this is a multivariate analysis taking all characters into account, one could quite easily have introduced a univariate analysis on separate characters to show variation between values for specific characters.

This graph is extremely interesting as it shows the dwarfing effect found among individuals of the sand dump population. This is also apparent when examining herbarium specimens. The plants collected on the sand dump tend to be very small when compared with specimens collected from Frankenwald or Krugersdorp. This seems to be a size distinction only as the plants were perfect in every other detail. This phenomenon is thought to be due to the impoverished soil in which they are growing. In the case of the mine dump it may be another adaption to the consistency of the "soil", the sand being very loosely textured.

The scatter diagram (Fig. 6) for *Pogonarthria squarrosa*, endorses the intermediate position of the Krugersdorp population, when looking at the two most important characters. There is a small amount of overlap with some individuals of the other two populations. The solid symbols which represent the mean values for the three populations further substantiate the positioning of the populations in relation to one another.

Table 3 contains discriminant values for three mine dump populations of *Cynodon dactylon*, one of the species planted on the dumps. The two slimes dam populations, Booyens Reserve (3/L/20) and 2/L/4 (Consolidated Main Reef Mine) initially compared are found to be distinct by virtue of the discriminant value R_0 . The values of the sand dump (3/A/1) show very close integration with the other two populations both drawn from mine dump localities. Twelve sand dump values which lie above the R_0 value are classified as belonging to population one, while the remaining eight values falling below the R_0 value can be considered to belong to population two. The F value of 10,056 calculated when comparing Booyens Reserve and 2/L/4 populations was highly significant at the 0,1% level; the D^2 value was 23,88.

The polygonal graph (Fig. 7) for *Cynodon dactylon* clearly illustrates this relationship, showing the similarity in many characters of the three populations

TABLE 3.
Discriminant values for three populations of *Cynodon dactylon* (L.) Pers. For explanation, see text, p. 33.

3/L/20 Booyens Reserve Values	3/A/1 Sand Dump Values	2/L/4 Slimes Dam Values
	- 18,745 77	
- 21,975 62	- 20,348 86	
- 22,127 06		
	- 23,483 26	
- 23,735 75		
- 24,549 91		
- 24,858 67		
- 25,404 60		
- 25,492 29		
	- 26,085 94	
- 26,472 69	- 26,618 07	
	- 26,712 77	
- 26,849 64		
RI - 27,582 3		
- 27,655 24		
- 27,924 36		
- 28,135 06		
	- 28,167 53	
- 29,058 78		
- 29,345 00		
- 29,885 91		
- 30,586 99		
- 31,124 66		
- 31,520 17		
- 32,042 69		
- 32,901 73		
	- 33,078 28	
	- 35,285 08	
	- 36,374 69	- 36,008 82
	- 36,708 44	
	- 37,723 51	
R ZERO - 39,5240		
- 39,538 47		
- 42,779 97		
- 42,873 47		
	- 44,726 56	- 44,605 16
		- 45,537 52
		- 45,944 85
- 46,531 49		
- 46,620 64		
		- 46,823 26
		- 47,702 85
		- 47,906 40
		- 47,947 75
- 48,646 03		
		R2 - 51,465 8
		- 51,562 53
		- 51,763 24
		- 53,169 54
		- 54,054 40
		- 54,683 87
		- 54,951 31
		- 55,519 13
		- 55,682 95
		- 57,484 95
		- 58,101 26
		- 58,390 56
		- 61,477 43
	- 91,137 76	

which are closely integrated. The Booydens Reserve population, with the smallest mean values, forms the polygon lying nearest to the centre point of the radii. An interesting feature of this graph is that all three polygons have a comparable shape, showing that there is similarity in all characters.

The scatter diagram (Fig. 8) for *Cynodon dactylon* shows a close integration of individuals of all the populations at the centre of the graph. The individuals do not show segregation into distinct population groups when these two characters are considered.

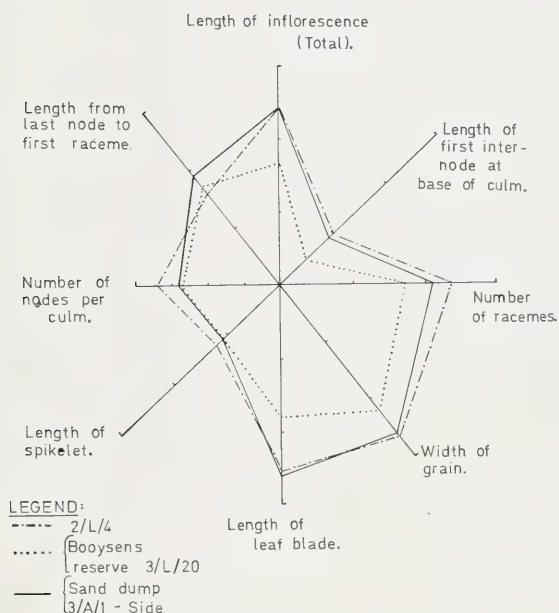


FIG. 7.
Polygonal graph for *Cynodon dactylon* (L.) Pers.

Table 4 shows the discriminant values for *Hyparrhenia hirta*. The F value calculated for the comparison of Booydens Reserve (3/L/20) and Frankenwald populations was 7,95 which was significant at the 0,1% level. The D^2 value for this analysis was 16,92. This table shows a close integration of the discriminant values of Booydens Reserve and Krugersdorp. Both samples with the exception of four Krugersdorp individuals fall on the R_1 discriminant value side of the discriminant index. The similarity between the two populations may

TABLE 4.
Discriminant values for three populations of *Hyparrhenia hirta* (L.) Stapf. For explanation,
see text, p. 33.

3/L/20 Booyens Reserve Values	Krugersdorp Values ("Natural" Population)	Frankenwald Values ("Natural" Population)
	-18,576 63	
	-21,492 75	
	-22,878 17	
-23,410 13		
-23,727 72		
-25,629 53		
-26,044 62		
-26,292 77		
	-26,543 26	
-27,418 76		
-28,068 63		
	-28,274 05	
	-28,366 38	
-28,522 20		
-28,682 02		
	-29,911 54	
<i>R1</i> - 30,059 7		
-30,140 58		
	-30,550 51	
-30,711 99		
-30,827 79		
	-30,889 66	
-31,275 21		
-31,623 57		
	-32,203 43	
	-32,470 75	
-33,207 37		
-33,512 91		
-34,845 08		
	-34,877 30	
-34,951 57		
-35,046 25		
	-36,188 22	
-37,255 86		
	-37,418 38	
	-37,444 02	
	<i>R ZERO</i> - 38,521 3	
	-40,053 74	
		-41,008 24
		-41,719 44
		-42,308 21
		-42,787 54
	-42,907 65	
		-43,557 88
	-43,949 92	
		-43,994 96
		-44,002 01
		-44,376 86
		-45,074 45
		-45,306 37
		-45,644 04
		-46,545 23
		<i>R2</i> - 46,982 9
		-47,004 07
		-47,066 82
		-48,484 28
		-49,397 22
	-49,575 27	
		-51,874 47
		-52,895 63
		-52,968 80
		-53,349 44
		-54,669 82

be due to the altitudinal similarity of the two areas from which these samples were drawn. BooySENS Reserve is 1 712 metres above sea level and the Krugersdorp population was collected at 1 645 metres above sea level, whereas Frankenwald is only 1 493 metres above sea level. This can perhaps be considered to be a type of geographic variation but would require further investigation. Notice that all the Frankenwald values lie on the opposite side of the discriminant index (R_0) forming a distinct population.

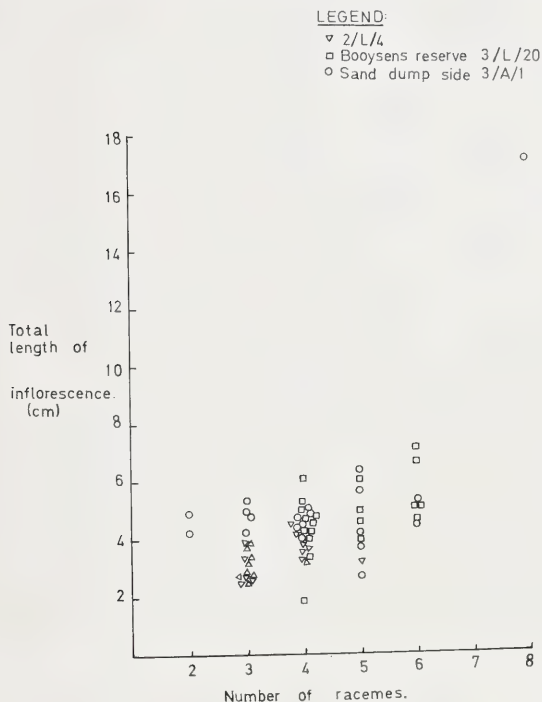


FIG. 8.
Scatter diagram for *Cynodon dactylon* (L.) Pers.

The polygonal graph (Fig. 9) for these three populations of *Hyparrhenia hirta* shows the BooySENS Reserve population to be an intermediate population when considering the first three characters; width of leaf blade just above the ligule, length of floret and length of awn. The outer polygon is that of the

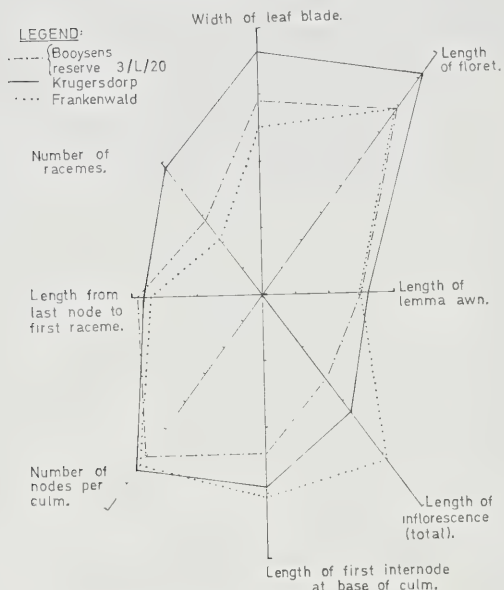


FIG. 9.
 Polygonal graph for *Hyparrhenia hirta* (L.) Stapf.

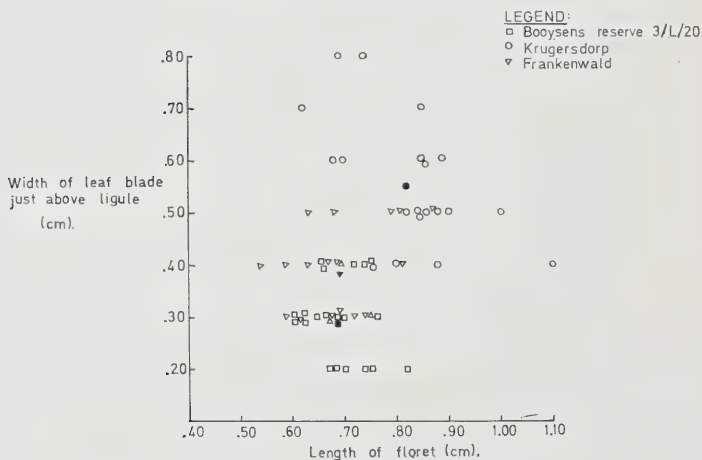


FIG. 10.
 Scatter diagram for *Hyparrhenia hirta* (L.) Stapf.

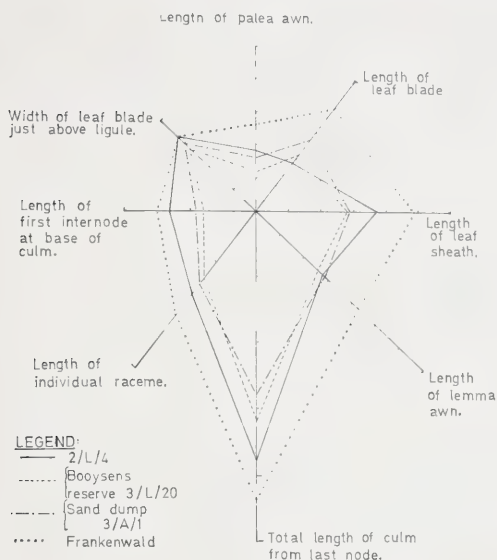


Fig. 11.
Polygonal graph for *Chloris gayana* Kunth.

Krugersdorp population while the Frankenwald and Booyens Reserve populations overlap for certain characters.

The scatter diagram (Fig. 10) for *Hyparrhenia hirta* shows individuals of the Frankenwald and Booyens Reserve populations to be closely associated when considering only the two most important characters. The individuals of the Krugersdorp population show a wide dispersion while the Frankenwald population is depicted as an intermediate population when considering mean values (which are represented by solid symbols). However, overlap at both extremes with the other two populations also occurs.

The polygonal graph (Fig. 11) for *Chloris gayana* shows the Booyens Reserve population with the lowest mean values occupying a position closest to the central point of the radii. The polygon representing the Frankenwald population is seen to be distinct, while the three mine dump populations compared have very similar polygons.

CONCLUSIONS

This study indicates that the sand dump populations were very different from the "natural" populations studied when many characters were considered.

The sand dump populations show the greatest amount of variation and remain distinct when compared with populations collected from the slimes dams. The populations collected from the slimes dams had discriminant values which compared favourably with one another and with the "natural" populations collected. With many species, overlap of discriminant values was obtained between one slimes dam population and another or with some of the "natural" populations. Although significant differences between populations were always obtained there seems to be a large amount of overlap when all characters are considered. The overall result thus indicates a high degree of uniformity among plants of populations growing on the slimes dams, and similarity to those of "natural" populations.

On Booysens Reserve, a constituent of purpleveld, *Hyparrhenia hirta*, was collected and since this work was completed *Themeda triandra* has been found growing on the following slimes dams: 3/L/14, 3/L/4 and 2/L/8. This is a step forward in the sequence of succession and seems to refute Roux's (1969) statement: "Whether succession will proceed to *Hyparrhenia*, as it has done on the cinder-covered dumps, remains to be seen. That the protected dumps will ever go to purple-veld seems unlikely, even in centuries to come. Apart from other considerations, the extension of built-up areas on all sides has pushed the purple-veld miles away and this process is likely to continue. The possibility that seeds of purple-veld grasses will reach the dumps will steadily diminish, for these seeds are not very mobile."

This study has shown that there are observable differences between "natural" and mine dump populations. Further research is necessary in order to provide an explanation for the variation and differences detected in terms of the genetic resources of the population, environmental conditions prevailing on the dumps and the general physiology of the plants.

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This research was undertaken during 1971/72 in the Department of Botany, University of the Witwatersrand. During this period F. M. Thatcher held a C.S.I.R. bursary and in addition was awarded the Edward Roux Scholarship in Bioecology (University of the Witwatersrand) for 1971. Thanks are due to the Chamber of Mines Vegetation Unit and Rand Mines Properties Ltd. for permission to work on the mine dumps and for providing invaluable help.

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ROBERT BROWN AT THE CAPE OF GOOD HOPE

J. P. ROURKE

(*Compton Herbarium, Kirstenbosch*)

ABSTRACT

The hitherto unpublished diaries kept by Robert Brown and Peter Good during their visit to the Cape in October–November 1801 are reproduced. Their collecting during an 18 day stay was confined to the Cape Peninsula. On sailing out of False Bay, the observation of “Red Water” (a plankton bloom) and its subsequent investigation, led to the discovery that the phenomenon was caused by microscopic aquatic organisms.

UITTREKSEL

ROBERT BROWN AAN DIE KAAP VAN GOEIE HOOP

Die tot hertoe ongepubliseerde dagboeke, gehou deur Robert Brown en Peter Good tydens hulle besoek aan die Kaap in Oktober–November 1801 word weergegee. Hulle versameling tydens 'n 18-daagse besoek was beperk tot die Kaapse Skiereiland. Tydens die vaart uit Valsbaai het die waarneming van “Rooi dood” (’n plankton-vermeerdering) en die daaropvolgende ondersoek daarvan gelei tot die ontdekking dat die verskynsel veroorsaak is deur mikroskopiese waterlewende organismes.

INTRODUCTION

On the 18th of July 1801, His Majesty's Ship *Investigator* sailed from Spithead, bound for the Antipodes. Captain Mathew Flinders was in command and among his staff was a young naturalist, Robert Brown, who was about to be launched on his spectacular botanical career. The principal object of their voyage to Terra Australis was that of “completing the discovery of that vast country”, to quote the words of Flinders himself. The botanical investigations during the voyage were to be conducted by Robert Brown, assisted by Ferdinand Bauer as natural history painter and Peter Good, a gardener from Kew.

Brown's travels and collecting activities in Australasia have been well documented (Giblin, 1930; Burbridge, 1956; Willis, 1956; Stearn, 1960), but his visit to the Cape, apart from a brief reference to it by Britten (1920), has largely been ignored. This is not really surprising since the Cape visit lasted only 18 days, and was, by comparison with the years spent in Australasia, quite unimportant. However, while the *Investigator* was being revictualled at Simonstown, Brown took every opportunity of examining the surrounding countryside and vegetation. Despite the fact that the Cape Peninsula had been comparatively well explored botanically since 1652 and could hardly be expected to yield the novelties awaiting discovery in Australia, Brown did nevertheless



succeed in discovering two new species of *Serruria*:—*S. foeniculacea* R. Br. (from near Constantia) and *S. flagellaris* R. Br. (from near Simonstown). They were described nine years later in his famous paper "On the Proteaceae of Jussieu". Both names were founded on his own collections.

As it was spring it is understandable that Flinders had some difficulty in persuading his colleagues to quit the Cape:

"In taking so early a departure though it were to proceed to the almost untrodden, and not less ample field of botany, New Holland, I had to engage with the counter wishes of my scientific associates; so much were they delighted to find the richest treasures of the English green house, profusely scattered over the sides and summits of these barren hills."

(Flinders, 1814: 43)

Brief as it was, the visit must have made a lasting impression on Brown, for, many years later in December 1834 when recalling his collecting forays at the Cape in conversation with W. H. Harvey, he remarked to Harvey that "some of the pleasantest botanizing he ever had was on Devil's mountain near Cape Town" (Anon., 1869: 46). The fact that Robert Brown did visit the Cape and did have the opportunity of collecting specimens and studying the Cape Flora in the field is of some interest, particularly to local botanists even though it is such a short chapter in the annals of South African botany. For this reason it seemed desirable to publish that part of Brown's diary concerning his stay at the Cape so that his collecting itinerary might be made known. In addition, the relevant part of Peter Good's diary is also reproduced here.

THE DIARIES OF BROWN AND GOOD

During the voyage, Brown made brief, somewhat irregular entries in his diary. Most of the entries are terse and telegraphic with few embellishments although it would appear that it was his intention to write up a fair copy of the diary in a less abbreviated form. This can be deduced by comparing the two entries for October, 17th. However, no further pages of the fair copy could be traced, leaving one to assume that he abandoned the idea.

Peter Good, who accompanied Brown on his collecting trips at the Cape, left a far more detailed diary. Good's diary complements Robert Brown's to such an extent that the two must be studied together. At the time of writing this paper, the portions of both diaries dealing with the Cape visit were unpublished.

A generous allocation of space in any treatise dealing with the history of botany during the 19th century will almost certainly be given to the life and work of Robert Brown. Little, however, seems to be known of Peter Good,

FIG. 1.

Robert Brown (1773–1858), at about the age of 77. The portrait is by T. H. Maguire from *Portraits of Honorary Members of the Ipswich Museum*, 1852.

the young Scot who served the Flinders expedition as a gardener and who Brown found such valuable assistant. In 1796 he travelled to Calcutta to bring Christopher Smith's collection of plants back to England. On his return to Kew he held the position of foreman until March 1801 when he was appointed to the Flinders expedition "to collect seeds for his Majesty in New South Wales" (Salisbury, *Paradisus Londinensis* tab. 41), at a salary of £100. During the circumnavigation of Australia, Good contracted dysentery soon after the vessel had departed from Timor. He died at Sydney on the 11th of June 1803 where he was buried shortly afterwards. A great many of the Australian plants grown at Kew in the early 19th century were raised from seeds collected by Peter Good.

The significance of Good's diary is that it is much more complete than Brown's and in general, more informative, particularly as far as the Cape visit is concerned. Unlike Brown's short, sober entries that are confined almost entirely to botanical observations, Peter Good's journal reflects a lively interest in all aspects of life, particularly in the activities of his colleagues. The difference in the personalities of the two men is perhaps most clearly brought out by comparing their diary entries for October, 18th and October, 24th. A study of both journals has thus provided us with a reasonably clear picture of Robert Brown's botanical excursions on the Cape Peninsula.

In the sections of the diaries reproduced here, the punctuation and spelling of the original manuscripts are retained unaltered.

ROBERT BROWN'S DIARY

Sept. 23rd., 1801. The island of Trinidad¹ in sight, passed to the leaward of it.

Oct. 16th. In the morning saw land. It proved to be the Cape of Good Hope. In the afternoon anchored in Simons Bay.

Oct. 17th. Landed. Walked in neighbourhood of the town. Many of the plants I had never before seen. Number of heaths, striking Proteas: Mesembryanthema etc.

Another version of the same

I went ashore and walked in the neighbourhood of the town which is extremely barren, rocky, but rich in vegetable productions. A great number of the plants collected I had never before . . . (This sentence is incomplete in the diary—J.P.R.)

Oct. 18th. Walked across the hills behind Simonstown. Many additions. New Genera of Orchidacea, Satyria verum, Disa, Pterygodium. Birds: Trochili² spec. 2-3, Loxia³ 2-3 sp.

Oct. 19th. Remained on board.

Oct. 20th. Walked towards & behind Paulberg. Testudo⁴, many additional heaths, Orchidacea, Filices.

FIG. 2.

A page from Brown's diary showing entries made during his visit to the Cape.

Oct 27th

After breakfast set off for
around Table Mountain. The
concrete pass reached the summit
within 2 hours. Passed by a
very dangerous pass before Table
& Devils Berg.

Grew for along mountain
for good grass. Inca. Brown
mistle. Mistle.
Thallia lucida. Aechmea affinis
Bombyx. Musa nana. M.
Guzmania capensis
Splenium. Thymus. Thymus. M.
Alpin. Thymus. Thymus. M.
reached Tokyo about 9 P.M.

Oct 28

Walked from Tokyo to Shinjuku

Oct 29

Remained on board

Oct 30th

Visited the neighborhood of the

Yam.

Oct 31. A good west on the
for the last time. We left.

Oct. 21st. On board Lancaster . . .

Oct. 22nd. Walked in the neighbourhood. Few additional plants. Falco,⁵ Coluber.⁶

Oct. 23rd. Remained on board.

Oct. 24th. Walked to Tokay, the farm adjoining Constantia at the bottom of Steenberg. Additional Orchidacea and Leucadendron, Cliffortia graminea, Restiones varii, Juncus, Fuirena. Pass of Meausenberg. Sterile appearance of the Country except the band of the hills from the farm west of Tokay to Constantia. Dutch style of building houses well adapted to the climate.

Oct. 25th. Left Tokay, passed Constantia & Silver Place. Then across the hills which rest on Table Mountain. Reached the summit of Table Mountain a little before sunset. Attempted one pass down but obliged to return. At length discovered the Chasm commonly ascended & reached Cape Town about 9 P.M. Polypodium capense et al. species. Disperis 2 species, Disa racemosa, Drosera cuneata, capensis. Diosmata varia. Menyanthes.⁷ Cliffortia odorata. Hydrocotyle asiatica.⁸ Achrosticum nov. sp. in rupes prope summitat.⁹ Lichen aff Dusto,¹⁰ Orthotricha nonnulla.¹¹

The pass down to Cape Town is both difficult and dangerous and from the summit to the town one may walk in an hour & half.

Oct. 26th. Ascended Devil Berg. Gusts of wind extremely violent. Mountain rich in plants: espec. the smaller Orchideae Disae variae, Corycium obtectum in depressis . . . : Inter mon Diabole & urbem Cap. Wurmbea pumila, Filices varii, nov. genus Company's Garden.

Oct. 27th. After breakfast set off for Tokay. Ascended Table Mountain by the common pass: reached summit within 2 hours. Descended by a very dangerous pass between Table Mtn. & Devils Berg.

Drosera nov. absq. fructific.

Nov genus prox Erica divers fructu drupaceo¹²

Halleria lucida Lichen affinis

Burgessii¹³ Musca nonnulla¹⁴

Cunonia capensis

Asplenium Monanthemum valde affine.¹⁵

Reached Tokay about 9 PM

Oct. 28th. Walked from Tokay to Simonstown.

Oct. 29th. Remained on board.

Oct. 30th. Walked in the neighbourhood of the Town.

Oct. 31st. Mr. Good went ashore for the last time. He brought one new species of Pterygodium.

Nov. 1st. Remained on board.

Nov. 2nd. Went ashore, found nothing additional.

(There is no entry for Nov. 3rd.—J.P.R.)

Nov. 4th. Sailed. out of False bay. Near the entrance of the bay a singular appearance on the surface of the water at this time perfectly smooth occurred. It consisted of pretty broad stripes computed at from 40 to 60 yards in breadth & of comparable length, of a dull colour at a little distance strongly resembled the appearance of the surface over shoals but on sounding no change in depth was found to exist. The water taken on board from these stripes thro several of which the ship passed and examined under the higher magnification of Ellis' aquatic microscope was found to (contain?) a minute animalcule.

On the 6th. lost sight of land.

REMARKS ETC. ON BOARD HIS MAJESTY'S SHIP INVESTIGATOR DURING A
VOYAGE OF DISCOVERY

BY PETER GOOD.

Oct. 16th, 1801. At 8 am land in sight from deck. Fresh breeze with showers—in coming near the land appears very mountainous and barren, at the entrance of the bay many whales very near and what the sailors call thrasher 2 of which threw themselves entirely out of the water and such an enormous bulk falling into the water made a noise like the report of a musket. Dropt anchor at 6 PM in Simons Bay and found here 6 ships of war.¹⁶

Oct. 17th. Went ashore in morning in Company with Mr. Brown, Bauer & Allen and collected a great variety of fine plants, some insects and minerals. The plants for variety and beauty were beyond description. Some I had never seen before, particularly *Orchis*, *Drosera* & *Hemimeris* and many I had never seen in flower, returned on board about 6 p m loaded.

Oct. 18th. Went ashore in morning with Mr. Brown, Allen, Bell¹⁷ and were joined by Mr. Ryeley Surgeon of Lancaster flag ship, a friendly intelligent man and had a long walk over mountains and sandy deserts and collected a great variety of fine specimens of plants, some insects and birds. Mr. Ryeley led us to a house where we found an assembly of Hottentots dancing Scotch reels to Scotch tunes on the violin—returned on board about 9 PM.

Oct. 19th. Went ashore in morning at Mr Browns request over the same ground we had examined on the 17th. for several rare plants particularly ferns which had been spoiled by our eagerness to collect so many. I procured everything Mr Brown pointed out in high perfection as also a few plants neither of us had met with the two former days and returned on board about 5 PM very wet it having rained from noon.

Oct. 20th. Went ashore in morning with Mr. Brown, Bell, Allen etc. and were found by Mr. Ryeley and had a long walk over the mountains of Paulsberg. We came to a Dutch house¹⁸ where we dined heartily on Eggs at 6d. each. On returning over the same mountains by a different way saw many Baboons and a Bock we met with few plants but what we had found the preceeding days—Came on board about 9.

Oct. 21st. Went ashore with Mr. Allen and had a long walk over the mountains nearest to the Harbour—found two ferns and a Lichen which we had not met with before, also some *Stapelias* not in flower.

Oct. 22nd. Went ashore at 6 AM with Mr. Brown, Bell etc. and had a very long fatiguing walk over the barren sands and rocky mountains about Fish Hoegks Bay but met with few or no plants but what we had found the preceeding days. Mr. Bell & Mr. Brown's servant shot several beautiful birds and I killed a large serpent of a dangerous kind—next day was appointed to set out for Table Mountain & Cape Town. But on coming on board Mr. Brown complained of having fallen & hurt his leg which would prevent him for tomorrow.

Oct. 23rd. Sent some letters for England by the Countess of Sunderland, Indiaman, Capt. Eccleston—and in evening went ashore with Mr Allen and had a walk to Company Gardens¹⁹ which are useful but no wise ornamental—on the way found several *Orchis* among which *carnea* which we had not found before.

Oct. 24th. Set out early in morning in Compy. with Mr. Brown, Bell, Bauer etc. for Cape Town, each carried provisions and a large tin box for specimens etc.—we missed our way and it rained considerably—we came to a very elegant house where a young lady invited us in and presently entertained us with Tea, Bread, Butter, Cheese, Wine etc.—we learned the house is called Tokay belonging to a Mr. Johann Casper Loos who was at this time in Cape Town. As it continued to rain all the afternoon we accepted the Lady's kind invitation to remain all night.

Oct. 25th. Set out Early in the morning & passed Constantia, Silverplace etc. walking through district of *Protea melifera*²⁰ & speciosa and large woods of *P. argentea* which is here planted as timber. The country in this neighbourhood is extremely fertile. We then ascended a range

of mountains called Stein Berg adjoining Table Mountain and passed ridge after ridge till about 5 PM we got very near the summit of the Table—but it now came on a thick fog and rain—we had not long to consider our situation till we fell in with a small path—we followed and soon arrived at the opening of the mountain down to Cape Town—here we consulted whether to remain all night and examine the mountain in the morning and save ourselves the trouble of again ascending it but as we had little provisions and it continued to rain we all descended and arrived in the Town about 9. We enquired for the English Coffea house where they behaved to us with much civility & procured us loggings where we were well accommodated at a reasonable price.

Oct. 26th. Mr. Brown and I took a walk to the Devils mountain and collected a few plants and returned to Dinner when we met with Mr Westal²¹ who now joined us having left the Ship in Compy. with Mr. Allen the same day we did but had lost each other on the way and had fared very indifferently & slept one night at Constantia—after dinner walked in Compy's Gardens and about the Town—but it rained very heavy.

Oct. 27th. Breakfasted at 6 in morning and Mr. Brown & I set out to ascend the Table Mountain while Mr Bauer, Bell, & Westall set out the best way from Cape Town. Mr. Brown & I ascended to the top of Table Mountain in two hours but very unfortunately as we came to the top a thick fog and rain came on which continued all the time we were on the top and we had not descended far when the day cleared up & became fine—we continued several hours ranging the skirts of the mountain and found some fine heaths—*Saxifaria* & *obliqua*²² but very few things but we had before found—we descended a very steep bank with much difficulty by a way which probably never was before attempted—near the bottom we found ourselves in a wood of some extent of natural Timber of a good size, consisting chiefly of *Taxus elongata*,²³ *Royena lucida*, *Rhus lucida*, *Halleria lucida*, *Ceanothus africana* & *Erica triflora* 12 to 20 feet high etc.—In this wood which detained us 3 or 4 hours we found 4 or 5 sp. of Ferns which we had not found before, also several Mosses & Lichens, the *Polypodium capensis*²⁴ grew here with fronds 6 or 8 feet long—at length we fell in with a foot path and set out at a brisk walk for Tokay but were benighted some miles distant, however we found our way though not the most direct arrived time enough to meet a kind reception & partake of an elegant supper from Mr. Loos.

Oct. 28th. When we got up in the morning we found Mr. Bell and Westall in Bed in an adjoining room having lost their way and with difficulty got to this place at $\frac{1}{2}$ past 10. They were also kindly received and accommodated.—having thanked our kind host as well as we could be understood & got his address on purpose to send him some seeds he had expressed a wish to have we took our leave expecting to breakfast at Meuseburg 4 or 6 miles distant being eager to preserve the specimens which we had collected, when we arrived at Meuseburg we could procure nothing either to eat or drink but were informed we might at a toll a few miles farther on but when we arrived there we were in the same predicament. There was nothing now left but to proceed for the ship. When we arrived at the wharf about noon we found Mr Bauer who had past the night before too late to get on Board & had past the night in a tent with Mr. Crossley²⁵ and had not got on board this morning.—we then begged a passage on board from the Lancaster boat and got all safe on Board before one—and was very sorry to learn that Mr. Crossley was to leave us & return to England his health not permitting him to go the voyage, he had been confined to his cabin by indisposition a great part of the voyage.

Oct. 29th. Remained on board securing everything for sea.

Oct. 30th. Went ashore and had a long walk by myself found one sp. of *Orchidea* we had not before seen & several (new?) ones as also various other specimens.

Oct. 31st. As the ship was expected to sail tomorrow I went ashore with Mr Brown & had a walk along the shore where we gathered some specimens of granite plants etc. and also made necessary preparations for sea.

Nov. 1st. Remained on board all day expecting to sail every hour. Continued in same state of suspension as wind not permit us to sail till . . . (*This sentence is incomplete in diary—J.P.R.*)

(There are no entries for the 2nd or 3rd of November—J.P.R.)

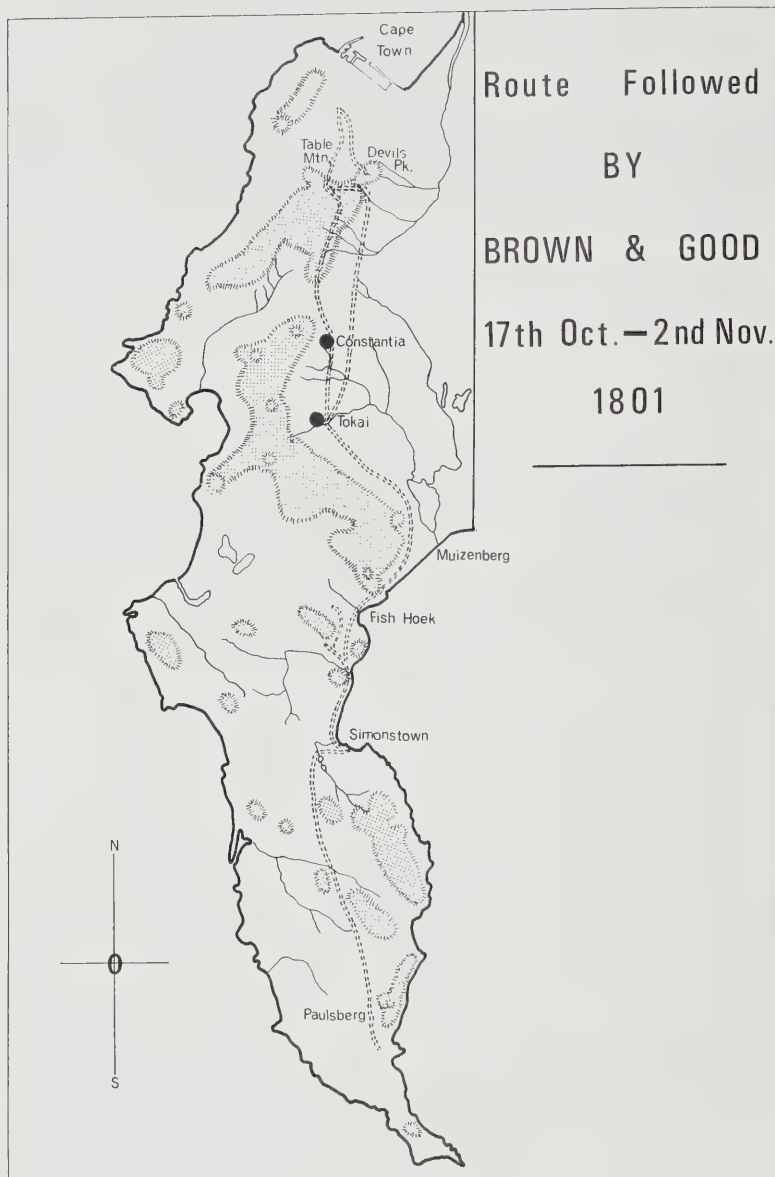
Nov. 4th. Got under way early in morning with light airs & calms till about noon being near the entrance of the bay a steady light Breeze from S. S.W. At this time a singular phenomenon appeared in the water which was tinged with dull red for a great distance round the ship. The lead was hove but perfectly clear, but on examination with the microscope it was full of small red insects—The sea appeared all in stripes of red and its natural colour, each stripe from 10 to 50 or 100 yards broad and as far as the eye could reach. After some hours it gradually disappeared.

Nov. 5th. Calm and serene in morning, a fine view of the land from Table Land to the High mountains of Hottentots Holland and even Cape Augullas—The land appeared to have many fine deep bays—at noon a fine Breeze sprung up from N.W. bore S.E.

Nov. 6th. Fresh Breeze as yesterday at noon a Brig seen standing to S.W.—out of sight of land.

EXPLANATORY NOTES

1. Trinidade: a small island off the coast of Brazil.
2. Trochili: Sunbirds, probably the Orange Breasted Sunbird, *Anthobaphes violacea*; the Malachite Sunbird, *Nectarinia famosa*; or the Lesser Double Collared Sunbird, *Cinnyris chalybeus*.
3. Loxia: Weaver birds (Family Ploceidae).
4. Testudo: A tortoise; either *Chersine angulata* or *Homopus areolatus*, the only two terrestrial tortoises on the Cape Peninsula.
5. Falco: A hawk, eagle or buzzard. This could refer to any bird of prey.
6. Coluber: A snake; most probably the Cape Cobra, *Naja nivea*.
7. Menyanthes: = *Villarsia capensis* (Houtt.) Merrill.
8. Hydrocotyle asiatica: = *Centella asiatica* (L.) Urban.
9. Achrostitum nov. sp.: Probably *Elaphoglossum conforme* (Sw.) Schott.
10. Lichen aff Deusto: Probably refers to *Lichen deustus* Lightf., a species Brown would have known in Scotland. What he observed on Table Mountain was almost certainly *Umbilicaria rubiginosa* Pers.
11. Orthotricha nonnulla: Some mosses; likened to the genus *Orthotrichum*.
12. Nov. genus prox Erica . . .: This is a very obscure remark. The plant referred to may be the small ericaceous shrub, *Scyphogyne urceolata* (Kl.) Benth., which has a fleshy calyx.
13. Lichen affinis Burgessii: Presumably a reference to *Lichen burgessii* Lightf., a species Brown would have known in Scotland. A species similar in appearance occurs on Table Mountain.
14. Musca non nulla: Some mosses.
15. Asplenium monanthemum: = *Asplenium monanthes* L.
16. 6 ships of War: According to Flinders (1814: 38) there were seven ships. These were H.M.S. *Lancaster*; *Jupiter*; *Diomedes*; *Imperieuse*; *Hindoostan*; *Rattlesnake*; *Euphrosyne*.



17. Allen, Bell: John Allen is listed as a miner and Hugh Bell as a surgeon, on H.M.S. *Investigator*.
18. Dutch House: This was probably the homestead of Uiterstehoek, marked as Smith's Farm on modern maps.
19. Company Gardens: I have been unable to trace any detailed information about the Company's Garden at Simonstown. Thunberg (1795) mentions it briefly in his description of Simonstown: "Besides a house belonging to the Company in which lives a resident, there are here an hospital, a warehouse, a slaughter house and a few farm houses belonging to individuals. The Company's garden lay at some distance". Flinders (1814) is scarcely more informative and tells us: "The road from Simon's Town to a place called the Company's garden, led close past the observatory". Since the observatory which Flinders mentions had been set up on the South side of Simons Bay, we may deduce that the Company's garden was situated somewhere between the present day Simonstown and Froggy Pond. Good's remark that the garden was "useful but no wise ornamental" suggests that it was used for the cultivation of vegetables and was therefore supplementary to the main garden at Cape Town.

The use of Simonstown as a port during the winter months was regularly practiced by Masters of the Dutch East India Company's vessels since this anchorage was very much more sheltered from the north westerly gales in winter than was Table Bay. The garden at Simonstown must have been established to supply the needs of shipping at the Cape during the winter months.

20. *Protea melifera* . . . etc.: = *P. repens* (L.) L.; *P. speciosa* L.; and *Leucadendron argenteum* (L.) R. Br.
21. Mr Westal: William Westall is listed as a "Landscape painter" in the complement of H.M.S. *Investigator*.
22. *saxifaria* and *obliqua*: = *Erica saxifaria* Bauer and *E. obliqua* Thunb.
23. *Taxus elongata* . . . etc. seq. etc.: = *Podocarpus latifolius* (Thunb.) R. Br. ex Mirb.; *Diospyros whyteana* (Hiern) F. White; *Rhus lucida* L.; *Halleria lucida* L.; *Noltea africana* (L.) Reich. f.; and *Erica triflora* L., respectively.
24. *Polypodium capensis*: = *Alsophila capensis* (L.f.) Sm.
25. Mr Crossley: John Crosley, astronomer on H.M.S. *Investigator*.

DISCUSSION

It is clear from these diaries that Brown's collecting was confined to the Cape Peninsula. The specimens he gathered during his 18 day stay are now preserved in the British Museum (Natural History), South Kensington.

FIG. 3.
Map showing the extent of Brown's exploration of the Cape Peninsula.

On October the 20th, the party made a short excursion in a southerly direction. Crossing the hills behind Simonstown by way of either Klaver Valley or Red Hill they walked southwards past Klaasjagersberg as far as Paulsberg. Another short excursion was undertaken on October the 22nd, this time in a northerly direction over the dunes at Glencairn to the Fishhoek Valley. Finally, on October the 24th Brown, Bauer, Good and Bell set off from Simonstown for Table Mountain and Cape Town. Following the track along the coast to Muizenberg, they turned inland, reaching Tokai by nightfall. At Tokai, the residence of Mr J. C. Loos, they were received by a young lady—presumably the daughter of Mr Loos. She was sufficiently engaging to have merited a mention by Peter Good but apparently failed to make any impression on Brown, who makes no mention of her. Leaving Tokai, the party crossed the Constantia Valley, passing the farms Groot Constantia and Silverplace (this must be either the present day Silverhurst or Witteboom), and commenced the ascent of Table Mountain.

Their descriptions suggest that the ascent of Table Mountain took place from near Constantia Nek, thence along the south eastern slopes above the Cecilia plantation, to Klaasens Kop, Nursery Buttress, Junction Peak and eventually the central table. By the time the summit had been reached, advancing darkness as well as deteriorating weather conditions forced them to descend. The descent route followed is clearly Platteklip gorge. To have departed from Tokai in the early morning, walked to Constantia Nek, climbed to the summit of Table Mountain, descended and reached the English Coffee House in Cape Town by 9 pm the same day, is a remarkable achievement, testifying to the fitness of Brown and his companions.

The following day was spent collecting on the north west slopes of Devils Peak and after dinner, a visit was paid to the Company's Garden which elicited no comment at all from either Brown or Good. This odd state of affairs may be ascribed to the fact that it was raining and probably getting dark, but one cannot help surmising that the garden had fallen into a state of neglect after J. A. Auge had resigned his position as superintendent in 1778.

The return journey to Tokai was no less strenuous than the outward journey. Leaving Cape Town after breakfast, Brown and Good separated from their companions and then ascended Table Mountain using the Platteklip Gorge route. They walked across the central and eastern tables and in due course reached the saddle between Table Mountain and Devils Peak. From the saddle they descended the precipitous eastern slopes "by a very dangerous pass" at the bottom of which they entered the Newlands forest. Although we will never know precisely which the "very dangerous pass" was, it can only have been one of the three parallel gorges that are situated between Devils Peak and Table Mountain on the south-eastern side. These three gorges, Els Ravine, Newlands

Ravine and Dark Gorge are only separated by a few hundred yards and of the three, Newlands Ravine seems the most probable route. No mention is made of the path they followed from Newlands to Tokai, but it seems likely that they skirted Wynberg Hill and walked across the Constantia Valley. At Tokai they again spent a night with the Loos family, returning to Simonstown on October the 28th. Thereafter only a few short excursions along the shore were under-



FIG. 4.

Tokai as it is today. Here, Robert Brown, Ferdinand Bauer and Peter Good spent two nights as guests of Mr Johan Loos and his family. This fine house was built by Andreas George Hendrik Teubes, almost certainly according to the plans of the famous Cape architect Louis Michel Thibault. Between 1800 and 1802 it belonged to Johan Caspar Loos since which time it has remained virtually unchanged.

taken as the ships complement were preparing for the voyage across the Indian Ocean.

As the *Investigator* sailed out of False Bay on November the 4th, the occurrence of "red water" attracted the attention of Brown and Good. Their notes may well be among the earliest recorded observations of "red water" along the Cape coast. Flinders fails to mention the phenomenon, which is rather strange considering he was naval officer.

Initially, it was thought that the reddish patches in the water were due to the presence of a shoal, but on examining a water sample, Brown soon determined that a microscopic organism was the cause. What they had observed was an early summer plankton bloom, a now well-known phenomenon in False

Bay. According to Grindley and Taylor (1964), two dinoflagellates, *Gonyaulax polygramma* Stein and *Noctiluca scintillans* Macartney are chiefly responsible for the reddish discoloration of the surface waters of False Bay during the early summer and autumn. It is possible that either or both of these species were present in the patches of "red water" that Brown studied.

On November the 6th Brown notes: "lost sight of land". From this point and during the crossing of the Indian Ocean there is little of interest in the diary.

But on the 6th of December 1801, 33 days after sailing from the Cape, Robert Brown recommences his diary with the following entry: "Land in sight, the south west coast of New Holland".

ACKNOWLEDGMENTS

The author is much indebted to the Keeper of Botany, British Museum (Natural History) for permission to reproduce parts of the diaries of Robert Brown and Peter Good, and also to Prof. E. A. Schelpe for advice on the correct nomenclature of the Cryptogams mentioned in the text.

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THE IDENTITY OF *EUCOMIS NANA* (BURM. F.) L'HÉRIT.

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ABSTRACT

An older, yet valid name for *Eucomis nana* (Burm. f.) L'Hérit. is proposed. The correct name for this taxon which is common in the South Western Cape should be *Eucomis regia* (L.) L'Hérit.

UITTREKSEL

DIE IDENTITEIT VAN *EUCOMIS NANA* (BURM. F.) L'HÉRIT.

'n Ouer geldige naam word vir *Eucomis nana* (Burm. f.) L'Hérit. voorgestel. Hierdie takson, wat algemeen in die Suidwestelike Kaap voorkom, behoort as *Eucomis regia* (L.) L'Hérit. bekend te staan.

Although the specific epithet "regia" was the first to be applied to the present day genus *Eucomis* there was, to date, no clarity as to the taxon to which it belonged. Several authors have applied this epithet to different species of the same genus and it has thus become necessary to clarify the situation.

1. Pre-Linnaean History

The only two references prior to 1753 to the genus *Eucomis* L'Hérit. are those of Petiver (1702-1709) and Dillenius (1732). Some authors, such as L'Héritier (1788) and Aiton (1789), applied the phrase-description of Petiver to *Eucomis nana* sensu Aiton but Ker Gawler (1812) on the other hand is of the opinion that this was not reliable since the phrase-name "Orchidea capensis, tulipae flora rosaceo" by Petiver was based only on a figure of a spike.

The more reliable reference prior to 1753 to a plant which undoubtedly falls within the present day genus *Eucomis* was that of Dillenius (1732). Since all the characteristics of the plant which appeared in the description and figure agreed with the later described *Eucomis nana* (Burm. f.) L'Hérit., it can be concluded that Dillenius' "Corona Regalis Lili folio, crenato" is as far as is known the earliest description of *Eucomis nana* (Burm. f.) L'Hérit.

2. Post-Linnaean History

In the first edition of *Species Plantarum*, Linnaeus (1753) gave the following description of *Fritillaria regia*: "racemo comoso inferne nudo, foliis crenatis" and regards the description and illustrations of Dillenius (1732) to be of the

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same plant. According to Van Houtte (1877) Linnaeus did not see the plant itself, but relied solely on the description and sketches of Dillenius—as the choice of the specific epithet shows. This would also explain Linnaeus' erroneous use of a generic name, *Fritillaria*, which had already been applied to another genus.

In 1768 a second type, namely *Fritillaria nana* (“racemo comoso foliis bifariis, amplexicaulibus, lanceolatis”) was described by Burman which represented one and the same taxon as *F. regia* L. Burman, however, does not quote the Dillenius plate for this species and on the contrary he enumerates *F. regia*. Since Burman's description is inadequate and erroneous (bifarious and amplexicaul leaves never existed in *Eucomis*) and is furthermore without a type, we cannot be sure that it is even a description of a *Eucomis* sp. Miller's (1768) description of *Fritillaria regia* L. deserves mentioning since it lead, without any doubt, to the correct identification of the species under the correct specific epithet *regia* and not *nana*.

During 1771 Linnaeus gave recognition to the name *F. nana* Burm. f. by repeating the description given by Burman (1768) in *Mantissa Plantarum*.

The genus *Fritillaria*, as constituted by Linnaeus in 1753, contained a number of divergent species and L'Héritier (1788) then separated the South African taxa under *Eucomis*. Within the new genus he recognizes three taxa, viz. *E. regia* (L.) L'Hérit., *E. nana* (Burm. f.) L'Hérit. and *E. punctata* L'Hérit.

From the description of *E. regia* (L.) L'Hérit. it is clear that he applied this name incorrectly to still another taxon, namely *Fritillaria autumnalis* Miller, since he also confused the characteristics of two different taxa, viz. *Fritillaria regia* L. and *F. longifolia* Hill. This, then, was the source of most of the confusion among later authors, such as Aiton (1789, 1811), Don (1796), Willdenow (1799) and Baker (1873). Aiton (1789), for example, circumscribed *E. nana* sensu Aiton quite correctly and also named it the dwarf *Eucomis*, but did not give a popular name to *E. regia*, since the previous circumscriptions were not clearly defined. The same applied to later authors in that they also showed a measure of clarity in connection with the identity of *E. nana* sensu Ait., but were still uncertain about the identity of *E. regia*. Baker (1873) even went so far as to use the name *E. regia* for the previously described *E. clavata* Baker.

A particularly discerning contribution to the identity of *E. nana* sensu Ait., *E. regia* sensu Ait., and *E. regia* (L.) L'Hérit. was published by Ker Gawler in 1812 in Curtis's Botanical Magazine. In his dissertation on *E. nana* sensu Ait. he regarded *Fritillaria regia* L. and “Corona Regalis Lili folio, crenato” of Dillenius (1732) as being synonymous. It is both remarkable and interesting that Ker Gawler (1812) considered “Corona Regalis Lili folio, crenato” to be synonymous with *E. nana* sensu Ait. and not with *E. regia* (L.) L'Hérit. or *E. regia* sensu Ait. as did previous authors, such as L'Héritier (1788), Lamarck

(1789), Willdenow (1799), Redouté (1807) and Aiton (1811). Even though Ker Gawler was the first to perceive and record this synonymy, he did not, however, confirm it since he gives no facts and still uses the name "nana" for his plate and not the older name "regia".

During 1967 Obermeyer corrected the author for the species *E. nana* as (Burm. f.) L'Hérit. Previously Aiton was assumed to be the author. Even though the author was now correct the epithet *nana* cannot be recognized, since the same species had previously been named *Fritillaria regia* L. and the sheet at Geneva, thought to have been the Burman type, proved to be a Thunberg collection (1774–75) and therefore cannot be the type.

CONCLUSION

1. Although L'Héritier erred in applying Linnaeus' name to another species (now recognized as *E. autumnalis* (Mill.) Chittenden) the correct name for the species should be *Eucomis regia* (L.) L'Hérit.

Basionym: *Fritillaria regia* L.

Type: tab. 92 & 93, fig. 109 & 110 in Dill. Hort. Elth. (1732).

2. The description of *Fritillaria nana* Burm. f. is too short to establish the species. As long as no type is found it must be placed under uncertain species.

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PRELIMINARY STUDIES ON SEED GERMINATION OF *DROSERA ALICIAE* HAMET

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ABSTRACT

Seed germination of the carnivorous plant *Drosera aliciae* occurred in a wide range of pH values with an optimum at pH 5.5. Germination proceeded at almost equally high rates in continuous light at 10°C, in the dark at 15°C and in a 14 hour photoperiod at 10/10°C and 15/10°C day/night temperature. Germination was stimulated slightly by KNO₃, H₃BO₃, gibberellic acid, indole-3-acetic acid and kinetin, the effect being greater with one year old seed than with fresh seed. An after-ripening period in the imbibed state of approximately 24 days was observed. None of the treatments, including dry storage of seed, reduced this period. This period could not be ascribed to an underdeveloped embryo. It is suggested that the after-ripening period is required for physiological changes to occur.

UITTREKSEL

VOORLOPIGE STUDIES OP DIE ONTKIEMING VAN *DROSERA ALICIAE* HAMET

Sade van die inseketende plant *Drosera aliciae* het oor 'n wye pH-gebied ontkiem met 'n optimum by pH 5.5. Ontkiemingstempo's was feitlik ewe hoog in konstante lig by 10°C, in die donker by 15°C en in 'n 14-uur fotoperiode by 10/10°C en 15/10°C dag/nag temperatuur. Ontkieming is effens deur KNO₃, H₃BO₃, gibberelliensuur, indool-3-asynsuur en kinetien gestimuleer. Die effek was groter met een jaar oue saad as met vars saad. 'n Na-rypingsperiode in die geïmbibeerde toestand van ongeveer 24 dae is waargeneem. Geen behandeling, insluitende opberging van saad in die droë toestand, het hierdie periode verkort nie. Hierdie periode kon nie aan 'n onderontwikkelde embrio toegeskryf word nie. Daar word voorgestel dat dit benodig word vir fisiologiese veranderings om plaas te vind.

INTRODUCTION

The carnivorous plant *Drosera aliciae* is, according to Obermeyer (1970), a marsh plant, also found in damp peaty areas and is common in the south-western Cape, extending to the eastern Cape. We have found it to occur abundantly in moist places in the Storms River—Knysna areas. First attempts at germinating seeds of this species on moist filter paper at 25°C over a four week period were unsuccessful.

As far as we could ascertain seed germination of this species has not been investigated. In fact carnivorous plants in general have been neglected in this respect. Swamy and Ram (1967) could not obtain germination of *Drosophyllum lusitanicum* seeds even after 8–10 weeks in culture. Excised embryos, however, germinated on a modified White's medium. Harder (1964) reported prompt

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germination in the same species but the condition of the seed and percentage germination was not given. Only the ovules from immature fruits of *Darlingtonia californica*, *Dionaea muscipula*, *Sarracenia flava*, and *S. purpurea* could be germinated by Withner (1964). Smith (1931) also states that the seeds of *Dionaea* are difficult to germinate. Vickery (1933) found seeds of *Drosera peltata* and *D. auriculata* to germinate readily in the laboratory on moist filter paper; seedlings commenced to appear after about 14 days.

This paper reports investigations on the effect of pH, temperature, light and various chemicals, including growth substances, on germination.

MATERIAL AND METHODS

Seeds were collected on various occasions from the same population of plants growing approximately three miles west of the Storms River bridge along the highway between Port Elizabeth and Cape Town. These were stored in open polystyrene containers in the laboratory.

Similar techniques were employed for all studies and for this reason only

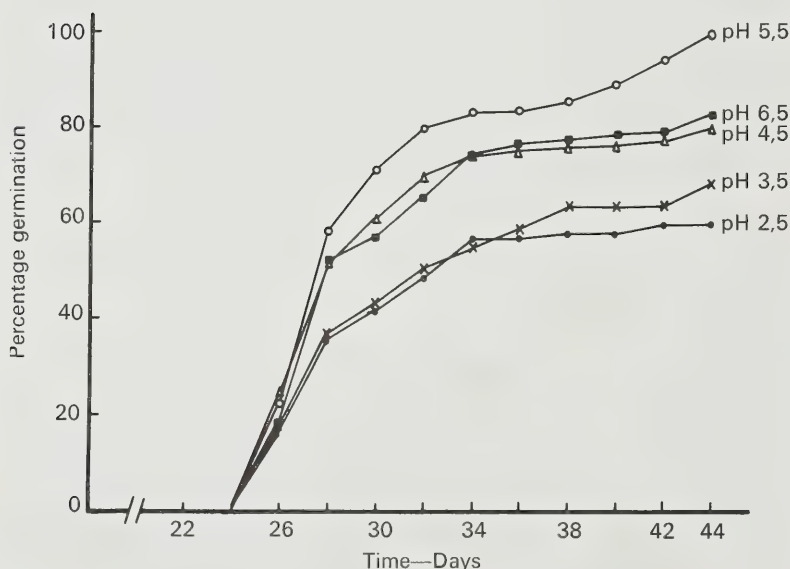


FIG. 1.
Time-course of germination at different pH-values. Mean of 5 replicates.

a general description is given here. Details on each experiment are presented in the section on results.

Prior to each experiment seeds were surface sterilized by submerging them in 95% ethyl alcohol for two minutes followed by three minutes in 0.1% mercuric chloride solution and rinsed thoroughly with a large volume of sterilized distilled water. All germination tests were performed on three layers of Whatman No. 1 filter paper in 9 cm oven sterilized glass petri dishes. In all cases 20 seeds were used per dish. Each treatment was replicated five times.

RESULTS

The effect of pH on germination of 5 month old seeds

Distilled water was adjusted to pH values of 2.0; 2.5; 3.0; 3.5; 4.0; 4.5; 5.0; 5.5; 6.0; 6.5; and 7.0 by small additions of 1N HCl or 1N NaOH. The filter paper on which seeds germinated was moistened with 5 ml of the above solutions. Seeds were exposed to weak light (2 000 lux) obtained from a combination of fluorescent tubes and incandescent lamps during 14 hours per day at 18–22°C in a growth room. The night temperature fluctuated between 9 and 12°C.

No germination occurred at pH 2.0. Although a fairly high germination count after 44 days was recorded at all other pH treatments, the highest germination rate occurred at pH 5.5 (Fig. 1). It is interesting to note that the first germinated seeds were observed only after 24 days.

The effect of temperature and light on germination of 6 month old seeds

Seeds were germinated in continuous weak light (2 000 lux), in the dark or in a light/dark cycle of 14 hours light and 10 hours dark per day. The continuous light and dark treatments were carried out at temperatures of 10°, 15°, 20° and 25°C in growth rooms. Fluctuating temperatures of 10/10°, 15/10°, 20/10° and 25/10°C were used in conjunction with the light/dark treatment. Deviation from the stated temperatures was of the order of $\pm 0.5^\circ\text{C}$. Counts of germinated seeds in the "dark" treatments were made in "safe" green light. The filter paper on which seeds germinated was moistened with 5 ml of a solution of distilled water adjusted to pH 5.5.

The effect of the treatments on germination obtained on the 34th day of the experiment is shown in Fig. 2.

A marked interaction between temperature and light treatment was observed. Regardless of the light treatment, the higher temperatures retarded germination. In continuous dark, germination was also retarded at 10°C. This effect was overcome by exposure to light. On the other hand the retarding effect of 15°C in the light was overcome in the dark. It is interesting to note that the germination behaviour in the light/dark treatment at 10°C was similar to that in

continuous light whereas at 15/10°C it was similar to that in continuous dark at 15°C.

At the lower temperatures an initial lag period of at least 23 days to onset of germination was also noted in this experiment. Where seeds were exposed to 25°C the first germinated seeds were recorded on the 33rd day.

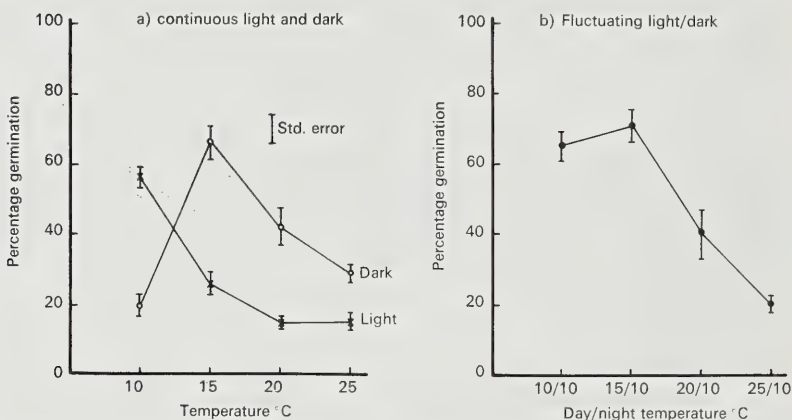


FIG. 2.

Effect of light and temperature on seed germination obtained on 34th day of experiment. Mean of 5 replicates.

The effect of certain chemicals on germination of fresh and one year old seed

Freshly harvested and one year old seed was germinated on filter paper moistened with 5 ml of solutions of KNO_3 , H_3BO_3 , indole-3-acetic acid (IAA—Nutritional Biochemicals corp), gibberellic acid (GA_3 ; Koch-Light) and kinetin (Koch-Light) at concentrations of 0,005; 0,05; 0,5 and 5,0 ppm. in 0,005 M phosphate buffer. The solutions had a pH of 5,5 after autoclaving. As controls, seeds were germinated in 0,005 M sterilized phosphate buffer, pH 5,5. The experiment was conducted in a Controlled Environments CE 7H growth cabinet set at a 14 hour photoperiod, 1 500 lux light intensity and a day/night fluctuating temperature of 15°/10°C. Germinated seeds were counted every second day for a period of 44 days.

As in the previous experiments, an initial lag period to onset of germination of approximately 24 days was found. No treatment shortened this period. The lag period was similar for both old and fresh seeds although the subsequent germination rate of old seed was markedly lower than that of fresh seed. No treatment was inhibitory to seed germination. In fact in most cases a slight

stimulation was observed. For simplicity the germination obtained on the 34th day of the experiment of that concentration for each chemical which produced the highest stimulation is shown in Fig. 3.

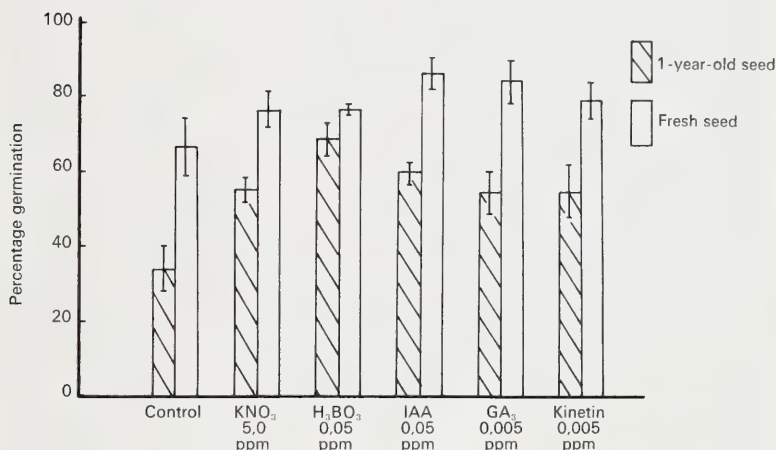


FIG. 3.

The effect of various chemicals on germination of 1-year old and fresh seed obtained on 34th day of experiment. Mean of 5 replicates.

Although all chemicals, at the concentration shown, stimulated germination, the effect on fresh seed germination was slight. The most marked effect was observed with old seed. Boric acid appeared to stimulate old seed germination more than any other chemical.

In addition to the treatments described above various other treatments were tested. These were: (i) soaking in tap water for 1 to 3 days, (ii) leaching in running tap water for 1 to 3 days, (iii) stratification at 5°C for 6–8 weeks, (iv) scarification in 50% H₂SO₄ for 1 to 15 minutes, (v) treating seeds with 98% ethanol for 1–15 minutes, (vi) germinating on filter paper moistened with 0.25 and 0.5% glucose and in other cases with the same sucrose concentration, (vii) exposing seeds on moist filter paper to an atmosphere of 100% oxygen for 3–5 days and (viii) soaking in a H₂O₂ solution (5–30%) for 24, 48 and 72 hours. With the exception of H₂O₂ none of these treatments had any effect on seed germination. In the case of H₂O₂ inconsistent results were obtained. In one out of three experiments soaking in 5% H₂O₂ stimulated germination slightly. In the other two experiments a highly inhibitory action was observed.

Observations on Embryo Structure.

In none of the experiments performed could seeds be induced to germinate promptly on imbibition. Invariably a period of approximately 24 days to onset of germination appeared to be required. To ascertain whether this was possibly due to an immature embryo, seeds which were set out for germination at 15/10°C in a 14 hour photoperiod were taken at one-day intervals, fixed in FAA, dehydrated with tertiary butyl alcohol (Johansen, 1940) embedded in wax and sectioned longitudinally. Sections were stained with safranin and fast green.

From an examination of a large number of ripe unimbibed seeds it appeared that the embryo was small but fully organized (Fig. 4a). On imbibition no morphological or size changes of the embryo were observed up to about the 17th day. At this stage the embryos of some seeds increased in size mainly due to anticlinal cell division in the region of the hypocotyl (Fig. 4b). Germination is finally attained by increased cell division in this region followed by cell division in the cotyledons (Fig. 4c and 4d).

DISCUSSION

From the results presented it is clear that seeds of *Drosera aliciae* do not germinate readily. None of the conditions tested induced visible signs of germination in less than about 24 days after the start of imbibition. This period was similar for fresh and old seed indicating that after-ripening does not occur during storage of seeds in the dry state. Subsequent germination rates of old seed was markedly lower than that of fresh seed.

A more severe condition has been reported for *Darlingtonia californica*, *Dionaea muscipula*, *Sarracenia flava* and *S. purpurea* by Withner (1964) in which mature seeds failed to germinate but ovules of immature fruits germinated readily. Similarly Swamy and Ram (1967) obtained germination only with excised embryos of *Drosophyllum lusitanicum*. Mature seeds failed to germinate even after 8–10 weeks. In contrast Vickery (1933) found seeds of *Drosera peltata* and *D. auriculata* to germinate readily on moist filter paper although it was stated that seedlings commenced to appear after 14 days.

From the results of the present investigation it appears that *D. aliciae* seeds require a period of after-ripening in the imbibed state; this period being

FIG. 4.

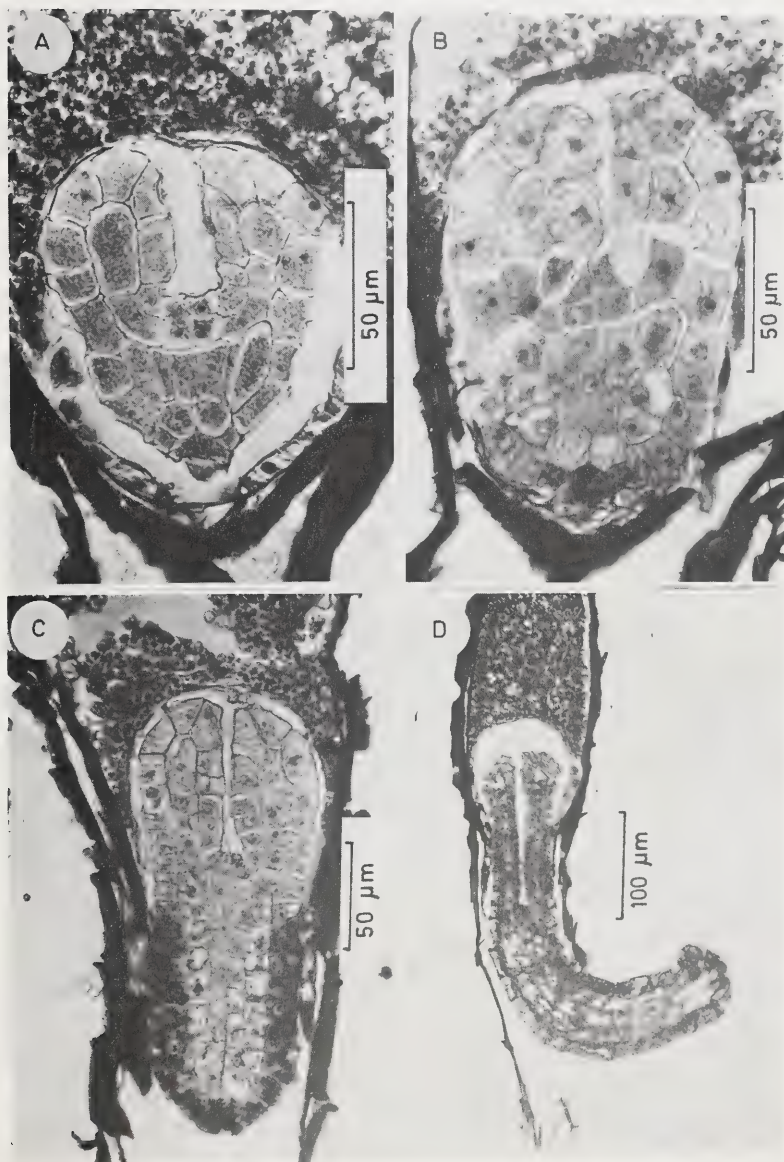
Longitudinal sections of germinating embryos of *Drosera aliciae*.

A—Embryo of ripe seed prior to imbibition.

B—Embryo showing anticlinal cell division in hypocotyledonary region after 17 days of imbibition.

C—Embryo imbibed for 21 days showing cell division in the cotyledons and hypocotyledonary region.

D—Protruding embryo 26 days after sowing.



shorter at a moderate temperature (15°C) than at a high temperature (25°C). Germinating seeds at 10°C or a pretreatment at 5°C for 6 weeks did not shorten this period. Since embryos appeared fully organized an after-ripening period for physiological changes to occur is suggested. A lack of water uptake did not appear to be responsible as sulphuric acid scarification had no effect on germination. Although impermeability of the seed coat to oxygen cannot be ruled out, this seems unlikely since incubating seeds in 100% oxygen for 3 to 5 days had no effect on germination behaviour.

An obvious interaction between temperature and light was observed. An interesting feature of these results was the finding that seeds exposed to a 14 hour photoperiod had equally high germination rates at 10°C and 15/10°C, whereas seeds kept in continuous light had highest germination rates at 10°C and those kept in the dark had highest rates at 15°C. Higher temperatures even if given only during the photoperiod were detrimental.

Although none of the chemical treatments induced prompt germination, increased germination rates subsequent to the initial after-ripening period were effected by KNO_3 , H_3BO_3 , IAA, GA_3 and kinetin. This effect was particularly pronounced in old seed. Furthermore H_3BO_3 had the greatest stimulating effect. This is interesting in view of the fact that Cresswell and Nelson (1972) have recently shown that boron is capable of breaking dormancy in *Themeda triandra* caryopsis and also stimulates germination of nondormant caryopsis. Only the "stimulating effect" was observed in the present study.

The stimulating effect of GA_3 on seed germination is well documented (Mayer and Poljakoff-Mayber, 1963). Although the majority of experiments testing the effects of IAA on seed germination have produced negative results, stimulation in a few cases has been observed (Lang, 1965). Kinetin effects on germination have mainly been associated with light-sensitive seeds (Evenari, 1965).

As a matter of interest it may be noted that distilled water slurries of various samples of soil in which plants were growing in the wild, had pH values of 5.3–5.8 which may have some bearing on the finding that the optimum pH for germination was 5.5.

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MEGASPOROGENESIS AND MEGAGAMETOGENESIS IN *ALOE AFRICANA* MILL.

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ABSTRACT

The campylotropous ovule of *Aloe africana* has three integuments. During megasporogenesis the megaspore mother cell gives rise to either a T-shaped or a linear tetrad of megaspores. Only the chalazal megaspore remains functional to produce an embryo-sac of the *Polygonum*-type.

UITTREKSEL

MEGASPOROGENESE EN MEGAGAMETOGENESE BY *ALOE AFRICANA* MILL.

Die kampilotrope saadknop van *Aloe africana* besit drie integumente. Tydens megasporogenese gee die megaspoormoedersel oorsprong aan of 'n T-vormige of 'n lineêre tetraede van megaspore. Slegs die megaspoor aan die kant van die chalaza ontwikkel verder. Die embriosak wat aangetref word is van die *Polygonum*-tipe.

INTRODUCTION

Aloe africana is found along the Eastern Cape coast from the Gamtoos River near Humansdorp to Port Alfred and Bathurst, and inland as far as Sheldon and Bedford (Jeppe, 1969).

Although the embryology of *Aloe africana* has not yet been described, Gioelli (1930) studied the embryo-sac development in five other species of *Aloe*, namely *A. arborescens* Mill., *A. Todari* var. *praecox* Borzi, *A. caecia* Salm., *A. varvari* Borzi and *A. ciliaris* Haw. In each case he found that the development of the embryo-sac conformed to that of the *Adoxa*-type. In this type of development no separating walls exist between the megaspore nuclei, and all four nuclei divide only once to give rise to a tetrasporic, eight-nucleate embryo-sac. Hence in the *Adoxa*-type development, there are only three divisions between the megaspore mother cell and the mature embryo-sac (Maheshwari, 1950). Joshi (1937) reports that research on other very closely related genera showed the *Polygonum*-type of embryo-sac and consequently he undertook a re-investigation of the embryology of the genus *Aloe*. Davis (1966) also recommends that Gioelli's report (1930) of the *Adoxa*-type embryo-sac requires further investigation, in view of the occurrence of the *Polygonum*-type in *Aloe vera* (Joshi, 1937). Schnarf and Wunderlich (1939) worked on *A. brownii*, *A. humilis*, *A. concinni*, *A. variegata* and *A. ciliaris*, all of which showed the *Polygonum*-type embryo-sac.

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MATERIALS AND METHODS

The material for the study was collected in the Redhouse district near Port Elizabeth during June, 1972 and fixed in Craff II (Sass, 1958). It was dehydrated in an ethyl alcohol/tertiary butyl alcohol series, embedded in paraffin wax (55°C) and sectioned at 10 μ m on a rotory microtome as prescribed by Brooks, Bradley and Anderson (1950). The sections were stained in safranin/fast green (Holtzhausen, 1972).

RESULTS AND DISCUSSION

The ovules of *A. africana* were found to remain orthotropous for only a very short while before becoming campylotropous. This is contrary to the condition reported by Joshi (1937) in *A. vera* where the orthotropous condition is maintained for a long time. There are three integuments; the outer one being an aril. Formation of this latter structure is initiated during megasporogenesis and it is fully developed by the time the embryo-sac reaches maturity. The aril, which develops from the funicle, does not grow into a very conspicuous structure and, as is shown in Fig. 1, it constitutes only a small collarlike structure around the funicle of the mature ovule. Joshi (1937) and Schnarf and Wunderlich (1939) observed similar structures in the *Aloe* species studied by them. The inner integument, which forms the micropyle, is usually two cell layers thick while the outer integument is three cell layers thick. Both of these are well-developed, approximately of the same length and extend over two-thirds of the length of the ovule. The nucellus is crassinucellate, having parietal tissue between the megaspore mother cell and the nucellar epidermis (Fig. 2a).

Megasporogenesis

The primary archesporial cell, which originates from one of the nucellus cells, is larger than the surrounding cells, has denser cytoplasm and a more prominent nucleus. This cell functions directly as the megaspore mother cell (Fig. 2a) without any intervening division. After a transverse division, the megaspore mother cell gives rise to a dyad (Fig. 2b). These two cells each divide again, resulting in a tetrad of haploid megaspores (Fig. 2c). The shape of the tetrad varies from linear to T-shaped, and intermediate forms are also found. There is usually no cell wall found between the two nuclei at the micropylar end (Fig. 2c). The chalazal megaspore remains functional to give rise to the embryo-sac, while the three micropylar ones degenerate (Fig. 3). The embryo-sac is thus monosporic.

Megagametogenesis

The single nucleus of the embryo-sac (Fig. 3) divides to form two nuclei which migrate to opposite poles of the embryo-sac (Fig. 4). Each of these

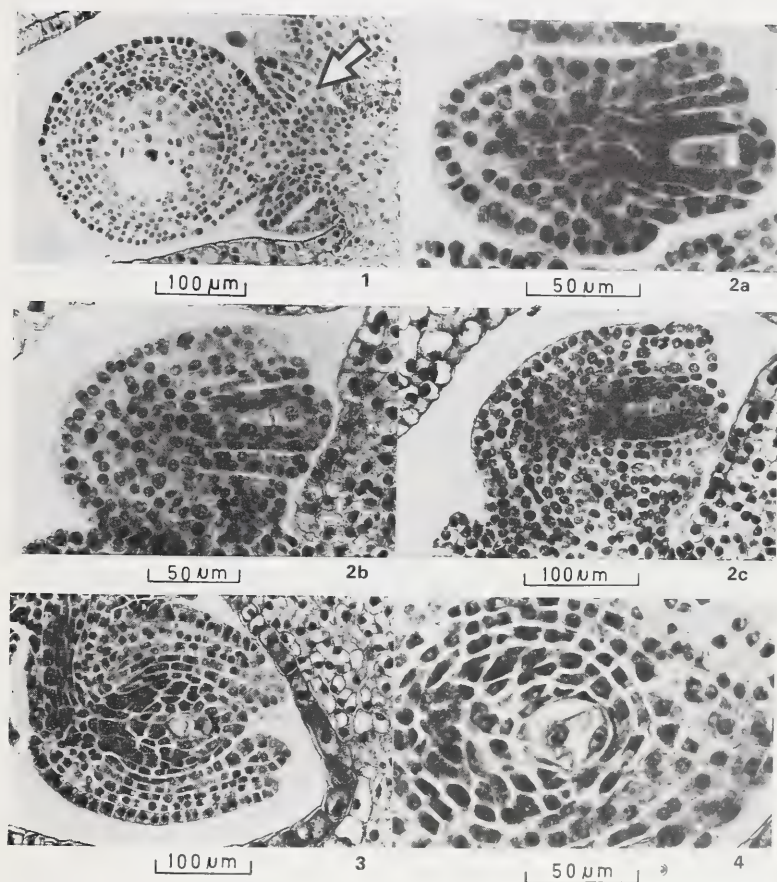


FIG. 1.

A longitudinal section through the mature ovule of *Aloe africana* showing the aril (arrowed) which develops from the funicle. Note the three antipodal nuclei.

FIG. 2.

Megasporogenesis in *Aloe africana*.

- (a) A longitudinal section through the ovule illustrating the large megaspore mother cell.
- (b) The megaspore dyad after the first division of the mother cell.
- (c) A linear megaspore tetrad. Note the absence of a cell wall between the two micropylar nuclei.

FIG. 3.

A longitudinal section through the ovule of *A. africana* showing the functional megaspore (= uni-nucleate embryo-sac). Note the degenerating megaspores to the right of the embryo-sac.

FIG. 4.

A longitudinal section through the two-nucleate embryo-sac of *A. africana*. (Micropyle to the right.)

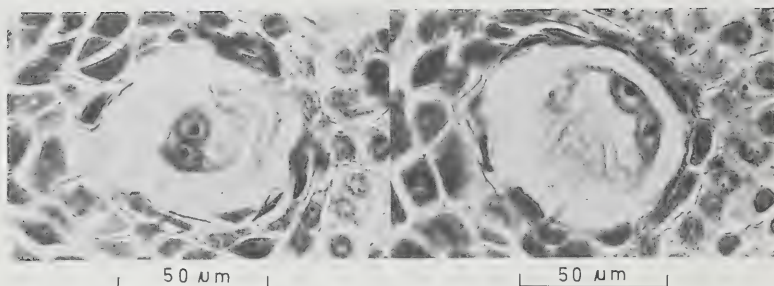


FIG. 5.

Longitudinal section of four-nucleate embryo-sac of *A. africana* showing (a) the chalazal and (b) the micropylar nuclei.

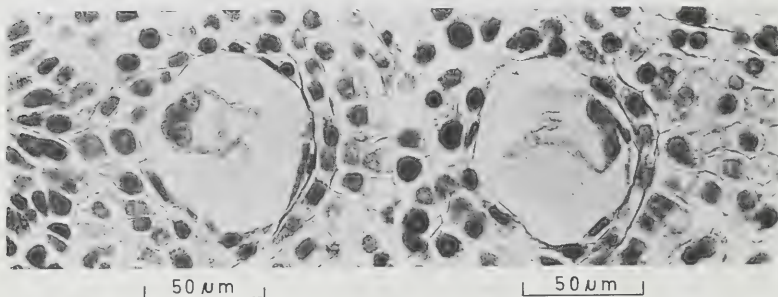


FIG. 6.

A longitudinal section through the eight-nucleate embryo-sac of *A. africana* showing (a) the four chalazal and (b) two of the micropylar nuclei.

divides again thus giving rise to the four-nucleate stage of the embryo-sac (Fig. 5a, b). After a third free nuclear division, the eight-nucleate stage is reached (Fig. 6a, b). The embryo-sac, being monosporic and eight-nucleate, is therefore of the *Polygonum*-type. In the mature embryo-sac, three of these nuclei aggregate at the chalazal end to give rise to antipodal cells; three at the micropylar end give rise to two synergids and the egg cell, and the remaining two, the polar nuclei, migrate to the centre of the embryo-sac and fuse to form the primary endosperm nucleus (Fig. 7). The antipodal cells persist until after the polar nuclei have fused. Development of the two synergids occurs before fusion of the polar nuclei. No filiform apparatus is present in the synergids.

CONCLUSIONS

In general, the results of this study are in accordance with those published by Joshi (1937) and Schnarf & Wunderlich (1939), that is, that the *Polygonum*-type embryo-sac is found in most species of *Aloe*. In view of this, it is suggested

that the report by Gioelli (1930) concerning the occurrence of the *Adoxa*-type embryo-sac in species of *Aloe*, be considered with some scepticism.

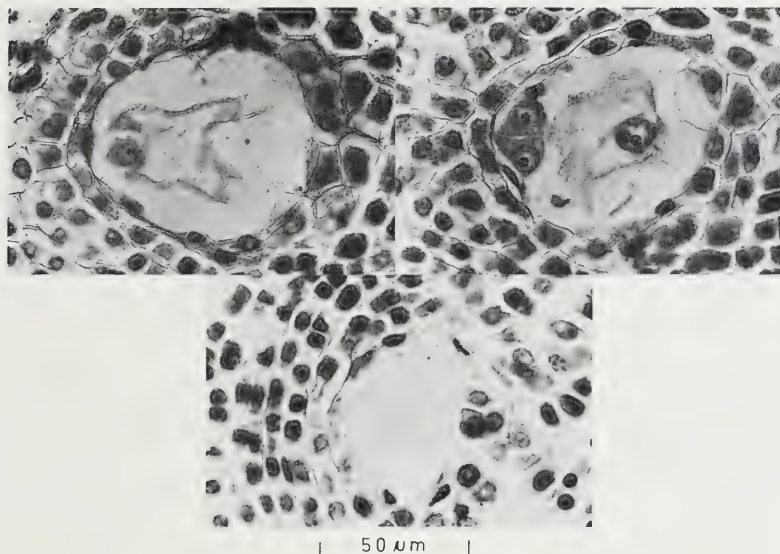


FIG. 7.

The mature embryo-sac of *A. africana* illustrating (a) the egg cell, (b) the synergids and secondary nucleus (fused polar nuclei) and (c) the antipodal cells.

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BOOK REVIEWS

COMMON TREES OF THE HIGHVELD, by R. B. Drummond and K. Coates Palgrave, with pp. 99, and 54 colour plates. Salisbury: Longman Rhodesia (Pty) Ltd Rh \$2,50 (\pm R2,50).

Fifty four common trees of the Rhodesian Highveld are enumerated in this book, each being illustrated by a half tone photograph and a colour plate depicting the leaves, flowers and fruits. As the authors point out, only the commonest species are dealt with from the area which they define as highveld, so in order to render the book as complete as possible a list of the most important species that had to be omitted has also been included.

One minor criticism is that the title may seem misleading to South African readers, who are accustomed to using the term "highveld" in a somewhat different geographical and ecological connotation. At the risk of being accused of undue provincialism, it did seem to me that "Common trees of the Rhodesian Highveld" might have been a more suitable title.

An alphabetical arrangement of families provides the basic plan of the book. Within the families, the species are arranged alphabetically, under their scientific names. Full author citations are given as well as important synonyms and common names in English, Shona and Ndebele.

The descriptions are brief, relying for the most part on the excellent colour plates to provide diagnostic details. It is a real pleasure to see Olive Coates Palgrave's beautiful water colour paintings reproduced again. They originally appeared in *Trees of Central Africa*, now out of print. Despite considerable reduction in the present publication, they have lost very little detail and are extremely well reproduced. Notes on distribution, folk lore, the uses of timbers, fruits, bark etc., and many other interesting observations on the biology of each species, fills the remainder of the text.

Common Trees of the Highveld meets all the requirements of a field handbook: it is light, of handy dimensions (140 mm \times 210 mm) and is printed on relatively tough paper, which should stand a reasonable amount of wear and tear. There is a good general index and an index to the vernacular names. At Rh \$2,50 (\pm R2,50), this book is amazingly good value for money. I sincerely hope it is the forerunner of many similar publications on Rhodesian trees.

J. P. ROURKE

TREES OF THE KRUGER NATIONAL PARK, VOL. 1, by P. van Wyk, with pp. XIV + 284, 99 full page colour plates. Cape Town: Purnell & Sons, 1972. R17,50.

How gratifying it is to know that animals are not the only inhabitants of the Kruger National Park and how fortunate it is that the flora of this great reserve should have an advocate as learned and eloquent as Mr. P. van Wyk. In introducing *Trees of the Kruger National Park*, of which Volume 1 is reviewed here, the author first presents a general picture of the area under consideration from climatic, geographical and geological viewpoints and also an outline of the principal vegetation zones supplemented by a vegetation map and a generous selection of colour photographs.

The major portion of the text is taken up with a systematic account of the tree species occurring within the boundaries of the park. These are arranged in numerical order, according to the National List of Trees, which in turn follows the Engler system. While the National Numbers are prominently indicated, no author citations are given after the binomials. This seems an unfortunate omission in a work of such high quality. For each species there is a statement of its known distribution within South Africa, beyond our borders and, more specifically, within the Kruger Park itself, backed up by a small distribution map. These maps are the only aspect of the whole volume that do not match up to the high standards set in the rest of the work. They tend to be more misleading than helpful. The small, inadequate dots used to indicate distributions are very difficult to pick out and one cannot help feeling that shading (as is used in a few instances) would have been more effective. A detailed description in a leisurely, expansive style then follows. The paragraphs dealing with the ecology and biology of each species are mines of information. There are notes on flowering and fruiting times, the texture and colour of the leaves in spring and autumn, the dietary preferences of browsing animals, the birds and other creatures attracted to the fruits, resistance to drought

and veldburning, germination of the seeds, growth rates, folklore, medicinal and economic properties and a good many other observations on the biology of each species. Here we have an assemblage of personal observations wrested from nature by the author over more than a decade. It is this vital data, so rarely written down, that elevates Mr. van Wyk's remarkable book to the rank of a highly original piece of biological research. It is indeed a sorry state that this type of data is so rarely allowed to infiltrate the pages of lifeless descriptions and sterile prose that so often characterise our monographs and floras.

Numerically, the legumes—here divided into 3 distinct families, Mimosaceae, Caesalpinaceae and Papilionaceae, occupy the bulk of the first volume. They are, in fact, the most important arborescent plant group discussed, comprising 30% of the total of about 200 plant species which attain the stature of trees in the Kruger Park.

No one can doubt that the colour photographs are the most outstanding feature of this book. These show a mature specimen of each species in its natural habitat with smaller photographs providing details of the bark, flowers and fruits. Endless patience must have been expended in assembling this collection of detailed portraits of the 95 species discussed. Not one plate in the reviewer's copy was out of register or showed any other defects in printing. A clear, bold typeface, together with a very pleasing layout, make this book a delight to use. There are relatively few misprints, and errors in translation such as there are (pg. 204, the family Papilionaceae is referred to as "this genus") are trivial and cannot be considered serious irritations. In short, this book gives the reader great satisfaction.

Every person who has the remotest claim to being a botanist should possess this magnificent treatise, as well as its companion volume which we now eagerly await.

J. P. ROURKE

PRINCIPLES OF DISPERSAL IN HIGHER PLANTS by L. van der Pyl. Second edition, with pp. xi and 162 and 26 figures. Berlin-Heidelberg-New York: Springer-Verlag, 1972. US \$12.60.

This second edition of *Principles of dispersal in higher plants* differs only in very small details from the first edition which appeared in 1969.

The ecology (biology) of reproduction of the higher plants is a topic that has been neglected. Van der Pyl with his *Principles of pollination ecology* (together with K. Faegri) and the book under discussion puts the subject in its proper perspective and showed that it's a matter of great ecological, biological and evolutionary importance.

Principles of dispersal in higher plants emphasises the principles of dispersal and how certain mechanisms effectively promote the life of the plant in its natural habitat.

The book starts with a short introductory chapter and three short chapters on, respectively, *General terminology*, *The units of dispersal* and *The relation between flowers, seeds and fruit*. *The ecological dispersal classes, established on the basis of dispersing agents* is the subject of the fifth chapter (p. 19–77). The following dispersing agents are discussed in what the author considers as an evolutionary sequence: invertebrates, fishes, reptiles, birds, mammals, ants, wind, water, transport on the outside of animals, dispersal by the plant itself and dispersal by weight only.

The concept of limitation of dispersal and the phenomenon that the same species may have different means of dispersal is set out in chapter six (p. 78–96). To understand dispersal it must be studied in the contexture of the plant community and to illustrate this point dispersal in deserts and rain forests and the dispersal of epiphytes and island floras are discussed. For dispersal to be effective the diaspores must be established and in a short chapter fixation, vivipary and germination as aspects of establishment are treated.

The evolution of dispersal organs is the subject matter of chapter eight (p. 105–125). The organs of dispersal in flowering plants are discussed from a special functional angle, namely the shift of function in spores, seeds and fruits. The discussion starts with the isoporous pteridophytes and ends with the angiosperms. The seed of the primitive gymnosperms and angiosperms were probably distributed by reptiles and the evolution of the dispersal organs can only be understood if the evolution of the dispersing agents are understood.

In the ninth chapter the concepts developed in the book are tested on the Leguminosae. The family is considered well suited to an inquiry into the ecology behind seeds and fruits, isolated from other processes, because its flowers are always entomophilous and because its

ovaries are simple and uniform. In the last chapter *Man and his plants in relation to dispersal* is discussed.

The book is well documented with an extensive list of references. The publications of Stopp and Leistner who made important contributions to dispersal ecology in South Africa, are listed. Zohary's *Plant life of Palestine* is not in the list, but is mentioned in the text. The publications of R. Marloth (e.g. the parachutes of *Leucadendron argenteum*) and A. V. Duthie (distribution of megaspores of Isoetes by earthworms) are not mentioned. The two indices cover the topics discussed and the plants mentioned in the text very well.

This book is indispensable for anyone studying, or doing research on, the dispersal of higher plants. Very little is known about the dispersal of plants in South Africa and many of the concepts put forward in this book must still be tested out in the South African flora. By so doing the South African flora will be better understood and a significant contribution is sure to be made to world botany.

The book makes a good impression. It is well-bound and the subject matter is well presented.

P. G. JORDAAN

DIE VEGETATION DES MECSEKGEBIRGES UND SEINER UMGEBUNG deur A. O. Horvát, met p. 376, 111 figure, 24 kleurfoto's en 'n vegetasiekaart in kleur. Budapest: Akadémiai Kiadó. 1972. Prys \$15.60.

Die boek is die resultaat van 'n intensiewe studie oor 'n periode van 30 jaar van die plantegroei van die Mecsekberge en sy omgewing in die suidooste van Hongarye.

Die resultate is ingedeel in ag hoofstukke. Na 'n algemene geografiese en 'n algemene plantgeografiese skets van die studietrein word 'n lang hoofstuk (p. 63–215) gewy aan die senologiese ondersoek van die gemeenskappe. Daarna word die resultate van die analise van die woudbodem weergegee en mikroklimaatondersoeke in verskillende gemeenskappe bespreek. In die sesde hoofstuk word die resultate wat van belang vir die kartering van die plantegroei is, bespreek en daarna die antropogene kultuurvegetasie en die woudtipes.

Om die inhoud van die boek te verstaan moet die leser ingelig wees oor die sintaksonomiese terminologie soos gangbaar in Europa.

Talle kleurryke plantgemeenskappe kan onderskei word waarvan sommige 'n midde-europese en ander 'n submediterreense, kontinentale of balkanse voorkoms het. Die flora is ryk aan mediterreense en oos-europese elemente. Woudgemeenskappe waarin *Quercus* soorte 'n belangrike rol speel, oorheers.

Die boek is goed gedokumenteerd en bevat 'n lang lys verwysings (p. 323–336). Dit is voorsien met nege registers—vir figure, kleurfoto's, tabelle, soorte van die woudgemeenskappe, soorte van die kruidgemeenskappe, name van die plantgemeenskappe, name van die soorte, name van persone en 'n baie kort onderwerpregister.

Die skrywer het 'n publikasie probeer lewer waarin plantgeografe, geografe, grondkundiges, klimatoloë, geoloë, pedagoë, bosboukundiges en agronome sodanige kennis oor die Mecsekberge en sy omgewing wat elkeen vir sy vakgebied nodig het, kan vind. Vir plantkundiges in Suid-Afrika sal die werk as 'n model kan dien, maar dit is tegelykertyd 'n openbaring dat aan sekere aspekte van die plantsosiologie en plantgeografie hier nog weinig aandag gegee is.

Die boek maak 'n netjiese indruk en is mooi gebind en goed versorg. Die figure, kleurfoto's en die veelkleurige plantegroeikaart is duidelik en vul die teks mooi aan.

P. G. JORDAAN

**STUDIES IN THE GENERA OF THE *DIOSMEAE* (RUTACEAE): 3.
EUCHAETIS ELSIEAE WILLIAMS SP. NOV.**

ION WILLIAMS

(Compton Herbarium, Kirstenbosch)

ABSTRACT

A new species of *Euchaetis* from the high mountains of the Ceres and Worcester Divisions is described.

UITTREKSEL

STUDIES VAN DIE GENERA VAN *DIOSMEAE* (RUTACEAE). 3. *EUCHAETIS ELSIEAE* WILLIAMS SP. NOV.

Een nuwe *Euchaetis* soort vanaf die hoë berge van die afdelinge van Ceres en Worcester is beskryf.

DESCRIPTION

Euchaetis elsieae Williams sp. nov. propria propter folia linear-elliptica obtusa, ad apice crassiusculis, intus plana, extus rotunda, flores pleurumque binatim.

Frutex ad 1,5 m, diffusa, erecta, ad basim monocaulis. *Cortex* aspera, fusca, cicatrices foliorum carens. *Ramuli* erecti, graciles, glabri, brevi, rubescenti. *Folia* variabilia, 2–9 mm longa, 1,1–1,7 mm lata, linear-elliptica, vel elliptica, obtusa, ad apice crassiusculis, marginibus hyalinis angustis crassis glabris vel minute scabris, sessilia, glabra, erecta, sparsa, conferta vel distans. *Flores* terminales, pleurumque binatim. *Bractea* 2,5 mm longa, 1 mm lata, ciliolata. *Bracteolae* duae, 2,5 mm longae, 1 mm latae, lanceolatae, ciliolatae. *Sepala* quinque, 3 mm longa, deltata, acuta, ciliolata. *Petala* quinque, 4,8 mm longa, 1,4 mm lata, oblanceolata, obtusa, transverse barbata, unguibus sparsim ciliatis. *Staminodia* quinque, vestigiala. *Fila* quinque, glabra, post anthesin 1,3 mm longa. *Antherae* quinque, ante anthesin 0,9 mm longae, 0,7 mm latae, vinosae, apicibus minute glandulosi. *Pollen* 42 μ longum, 22 μ diam., oblongum. *Discus* 5-sinuatus, ovarium excedens. *Stigma* capitellatum. *Stylus* glaber, 1 mm longus. *Ovarium* 5-carpellatum, 0,8 mm diam., glabrum. *Fructus* 5-carpellatus, 6,5 mm longus, glaber, cornibus perbrevis. *Semen* 4,3 mm longum, 2 mm latum, piceum, nitens.

Type: CAPE–3219 (Wupperthal). (—CB) on a ridge S.E. of Bloukop, Cold Bokkeveld, 4 400–4 600', Ceres Division, *Williams 1817* (NBG, holotype; PRE, STE, K, MO, M, S, BOL, C, isotypes).

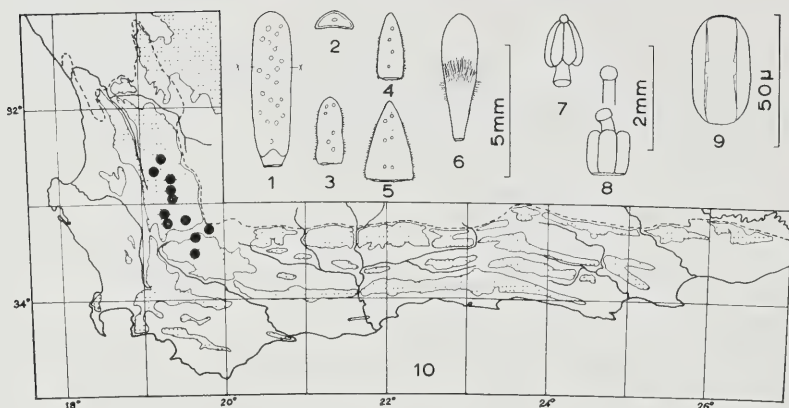


FIG. 1.

Euchaetis elsiaeae: 1, Leaf; 2, Section of leaf; 3, Bract; 4, Bracteole; 5, Calyx lobe; 6, Petal; 7, Anther; 8, Gynoecium; 9, Pollen; 10, Distribution.

This species was collected on the Matroosberg by A. Bolus and R. Marloth on the 1st January 1897 and again on the 19th January of the same year by Schlechter on the Gydoberg. Schlechter distributed many duplicates with the manuscript name of *Acmadenia macrostylidioides* but apparently never published a description. It was not again recorded until January 1940 when Miss Elsie Esterhuysen, in honour of whom this species is named, made two collections on the Matroosberg near Valschgatkloof. Thereafter she made many well documented gatherings from the high mountains of the Cold Bokkeveld and Hex River areas.

Shrubs up to 1,5 m after more than 50 years, normally much less, branching from near the base. *Bark* fairly rough, greyish-brown, without leaf scars. *Branches* slender, erect, glabrous, ashy in colour, divaricate, becoming leafless. *Branchlets* slender, erect, short, glabrous, reddish, shining, either not much hidden by the leaves or densely foliate. *Leaves* vary considerably in size, 2–9 mm long, 1,1–1,7 mm broad, linear-elliptic or elliptic, obtuse, thickened towards the apex, hyaline margins narrow, thick and smooth or scabrid, glabrous, sessile, adaxial surface flat becoming concave when dried, abaxial surface convex and gland dotted, adpressed or spreading-erect, distant or crowded, scattered. *Inflorescence* terminal, usually in pairs. *Bract* one to each flower, 2,5 mm long, 1 mm broad, oblong, obtuse, thickened at the apex, glabrous, gland dotted, ciliolate. *Bracteoles* two, 2,4 mm long, 1 mm broad, lanceolate, sub-acute, glabrous, gland dotted, ciliolate. *Calyx lobes* five, 3 mm long, 1,8 mm

broad, deltoid, acute, glabrous, gland dotted, ciliolate, adaxial surface very short-pubescent below. *Petals* five, 4,8 mm long, 1,4 mm broad, oblanceolate, obtuse. *Limb* white, glabrous, recurved. *Claw* narrowing to the base, transversely bearded and somewhat ciliate above. *Staminodes* five, 0,15 mm diam., each a minute vestigial translucent spherical gland. *Filaments* five, becoming 1,3 mm long, acicular, glabrous, curving inwards. *Anthers* five, before anthesis 0,9 mm long, 0,7 mm broad below, wine red, apical gland 0,2 mm diam. *Pollen* oblong, 42μ long, 22μ diam. *Disc* 5-sinuate, exceeds the ovary, exudes nectar. *Stigma* 0,25 mm diam., globose, green, capitellate. *Style* becoming 1 mm long, terete, glabrous. *Ovary* 5-chambered, 0,8 mm diam., glabrous, apices hemispherical. *Fruit* (from *Esterhuysen* 27907) 5-carpellate, 6,5 mm long, glabrous, gland dotted. *Horn* 1 mm long, with a spherical gland clasped at the apex. *Seed* (from *Esterhuysen* 27907) 4,3 mm long, 2 mm broad, black, shining.

SPECIMENS EXAMINED

CAPE—3219 (Wupperthal): (–CA) Southern Cederbergen, Hondverbrand Ridge, vlakke on E.spur, 21/4/1946 *Esterhuysen* 12750 (BOL, NBG); Clanwilliam, Elandskloof Mountains, 4 000', 25/9/1936 *Compton* 6557 (NBG); (–CB) Cold Bokkeveld, Bloukop, rocky plateau and E. slopes, 4 500–5 500', 1/10/1958 *Esterhuysen* 27907 (BOL); Cold Bokkeveld, Bloukop, S.E. ridge, 4 400–4 600', 8/6/1973 *Williams* 1817 (K, M, MO, NBG, PRE, BOL, C, S, STE); (–CD) Bokkeveld Sneekop, rocky W. & S.W. slopes, 5 000–6 000', 31/3/1963 *Esterhuysen* 30107 (BOL); (–CD) Skurweberg Peak, S. of Bokkeveld Sneekop, shaly and rocky S. slopes, 4 000–5 000', 1/1/1962 *Esterhuysen* 29446 (BOL). –3319 (Worcester): (–AB) Cold Bokkeveld, Gydoberg, 6 000', 19/1/1897 *Schlechter* 10051 (BOL, BR, MEL, PRE), 10/11/1946 *Walgate* 1116 (BOL); (–BA) Baviaansberg, N. of Karoopoort, rocky slopes, 5 000–6 000', 4/11/1962 *Esterhuysen* 29802 (BOL), 12/1/1956 *Stokoe* s.n. (SAM 70000); (–BD) Bonteberg, Eikenboschoek, S. slopes, 3 500–4 000', 3/11/1940 *Esterhuysen* 3671 (BOL, NBG, SAM), 3/11/1940 *Compton* 9955 (NBG); (–BC) rocky crest of ridge N. of Matroosberg and Sonklip, 3 000', 6/8/1951 *Esterhuysen* 18725 (BOL); Matroosberg, 5 500–6 500', –/1/1897 *Marloth* 2361 (PRE), 1/1/1897 *A. Bolus* s.n. (BOL 6361), 2/1/1897 *A. Bolus* s.n. (BOL Guthrie 4394); Matroosberg, rocky shale band above "Coat of Arms", 1/6/1958 *Esterhuysen* 27787 (BOL); Valsch Gat Kloof 4 000', –/1/1940 *Esterhuysen* 1544 (BOL); Roodeberg, 6 000', –/1/1941 *Stokoe* s.n. (BOL, SAM 58810), rocky W. slopes, 5 000–6 000', 27/12/1952 *Esterhuysen* 20909 (BOL), 10/10/1962 *Esterhuysen* 29720a (BOL); N. slopes above Valsch Gat Kloof, 5 000', –/1/1940 *Esterhuysen* 1499 (BOL); Conical Peak, Roodeberg slopes, 6 000', –/12/1940 *Stokoe* 7668 (BOL, SAM); near Peak C., 6 000', 24/1/1941 *Stokoe* 8177 (BOL); (–AB) Cold Bokkeveld, Rocklands Peak, rock outcrop on shale band, 5 000', 5/6/1955 *Esterhuysen*

24327 (BOL); (–DA) Kwadouws Mountains above Orchard, amongst rocks on plateau 3 000–4 000', 26/7/1944 *Esterhuysen 10317* (BOL, NBG SAM), 23/11/1944 *Esterhuysen 10926* (BOL); Kwadouwsberg, Witvlakke, 4 600', 16/5/1973 *Williams 1800* (NBG).

DISTRIBUTION, BIOLOGY AND VARIATION

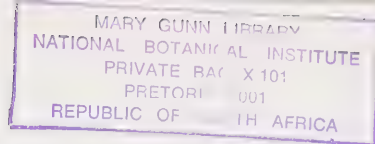
Euchaetis elsiae is a species confined to high mountains in the Cold Bokkeveld and Hex River areas, a distance of 105 km from North to South. It is found at altitudes of from 1 000 to 2 000 metres (3 000–6 500') above sea level on dry stony ground amongst rocks of the Table Mountain Sandstone geological series. It would appear to be in bloom nearly the whole year round in one locality or another. The only months when no collections have been made are February, March and May. However, this does not mean that this plant is not then in bloom. The type collection was made in April and fruiting material has been collected in October and November. Pollination is most probably effected by small insects. The style, which at first is very short and slightly deflected to one side, eventually lengthens, after the anthers have discharged their pollen, becomes erect and carries the stigma up into the throat of the flower just beneath the bearded petals. In this position it is most likely to receive pollen brushed off from any insect attempting to reach the nectar which is secreted by the disc surrounding the ovary at the base of the petals.

The leaves of *E. elsiae* when crushed have a scent of menthol or turpentine. The stems in cross-section show distinct annual rings. A section from the stem of a plant in the population from which the type material was collected, showed 50 rings. These plants were up to 1,5 m tall, and were in an area that obviously had not been burnt for a very long time. Young plants in the material *Esterhuysen 1499* showed 3 annual rings.

Variation in *Euchaetis elsiae* is most noticeable in the size and spacing of the leaves. Many plants appear to produce very short shoots with minute leaves closely overlapping (*Esterhuysen 3671*). Towards the north, however, populations have somewhat larger leaves which are more spread out. These variations may, to some extent, be due to climatic conditions. Unfortunately these plants have never been brought into cultivation and so comparisons between populations have never been made. Branches may be glabrous or somewhat pubescent and leaves may be glabrous or slightly scabrid with margins that may vary from smooth to scabrid.

DISCUSSION

This plant is placed in the genus *Euchaetis* Bartl. & Wendl. because it possesses the following characters:— 1. *petals* transversely bearded in the vicinity of the throat of the flower; 2. *staminodes* vestigial; 3. *anther* bears a minute apical



gland; 4. *disc* exceeds the ovary; 5. *stigma* capitate; 6. *style* short; 7. *filaments* and *style* glabrous; 8. *ovary* 5-carpellate; 9. *fruit* short horned.

Euchaetis elsieae is recognised as distinct on account of its having linear-elliptic obtuse leaves, somewhat thickened at the apex, flat on the adaxial surface (concave when dried) and rounded on the outside, with the flowers borne usually in pairs. It differs from *Euchaetis glomerata* Bart & Wendl. *Euchaetis elata* Eckl. & Zeyh., *Euchaetis linearis* Sond. and *Euchaetis flexilis* Eckl. & Zeyh., all of which have flowers aggregated into multiflorous heads and leaves varying from linear to lanceolate. It is nearest to *E. flexilis* but differs in that the apex of the leaves in *E. elsieae* is thickened whereas in *E. flexilis* it is sacculate.

A SCANNING ELECTRON MICROSCOPIC INVESTIGATION OF THE POLLEN OF SOUTH AFRICAN *ACACIA* SPECIES

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ABSTRACT

Pollen of South African *Acacia* species was used as experimental material for studying techniques of scanning electron microscopy. Additional information on the pollen morphology of *A. albida* and *A. giraffae* was thus obtained. The taxonomic position of *A. albida* and *A. giraffae* is discussed briefly.

Microsporogenesis of *A. exuvialis* was examined as well as the surface structure of the anthers and their glandular appendages.

UITTREKSEL

'N SKANDEERELEKTRONMIKROSKOOP ONDERSOEK VAN DIE STUIFMEEL VAN SUID-AFRIKAANSE *ACACIA*-SOORTE.

Stuifmeel van Suid-Afrikaanse *Acacia*-spesies is gebruik as eksperimentele materiaal om tegnieke op die skandeerelektronmikroskoop te bestudeer. Hierdeur is bykomstige inligting in verband met die stuifmeelmorfologie van *A. albida* en *A. giraffae* verkry. Die taksonomiese posisie van *A. albida* en *A. giraffae* word kortliks bespreek.

Die mikrosporogenese van *A. exuvialis* sowel as die oppervlaktestruktuur van die helmknoppe en die klieragtige aanhangsel van die helmknop is ondersoek.

INTRODUCTION

Acacia pollen has previously been studied by Rosanoff (1866), Wodehouse (1935), Erdtman (1953, 1952), Selling (1947), Coetzee (1955), van Zinderen Bakker and Coetzee (1959) and Guinet (1969).

The three dimensional structure of the polyads and monads are clearly illustrated in these papers, but very little detail of the surface structure of the cells is shown. Van Zinderen Bakker & Coetzee (1959) have indicated that all the polyads of all South African *Acacia* species consist of 16 cells (monads) with the exception of *A. albida* (with 30 cells) and *A. giraffae* (with 26-48 cells). Coetzee (1955) has also mentioned that the monads of species with spicate inflorescences as well as those of *A. detinens* (*A. mellifera* var. *detinens*) and *A. pennata* (*A. schweinfurthii* pro parte) (with capitulum-like inflorescences) are not furrowed (grooved), whereas species with capitate inflorescences have grooved monads. According to characteristics other than pollen structure, *A. mellifera* and *A. schweinfurthii* belong to the series *Vulgares* (Benth., 1875). Guinet (1969) therefore correctly states that species of the series *Vulgares* (with

spicate inflorescences, including *A. mellifera* and *A. schweinfurthii*) have un-grooved monads, while species of the series Gummiferae (with capitate inflorescences), except *A. albida*, have grooved monads.

According to Coetzee (1955), the furrows (grooves) in the monads of *A. giraffae* are the of same type as those in monads of the remaining species with capitate inflorescences. Guinet (1969), by contrast, shows clearly that the grooves in the monads of *A. giraffae* are different from those in the remaining species of the Gummiferae. Neither Coetzee (1955) nor Guinet (1969), however, gives a detailed illustration or description of the polyads of *A. giraffae*.

In view of the large amount of available information on *Acacia* pollen, this study was not intended to be a complete revision of the work that has already been done on *Acacia* pollen. The pollen of some South African *Acacia* species was used merely as experimental material for studying techniques of scanning electron microscopy (SEM). A comparison of the observations made during this study, with observations on *Acacia* pollen made previously, was nevertheless considered relevant.

As it was not easy to distinguish the three dimensional structure of grooved monads with the SEM, it was necessary to compare scanning electron micrographs of the polyads with light-micrographs.

In order to understand the ontogeny of the polyads better, the microsporogenesis of *A. exuvialis* was also examined with attention being paid to the structure of the anther and its grandular appendage.

MATERIALS AND METHODS

Fresh pollen and/or pollen from herbarium specimens (untreated) was mounted on specimen holders, coated with gold palladium or gold and then studied on a Jeol JSM-U3 scanning electron microscope. Pollen of *A. albida*, *A. giraffae* and *A. exuvialis* was pretreated in a solution of 1 ml H_2SO_4 and 9 ml acetic anhydride (Erdtman, 1943) and studied under the light microscope as well as the SEM.

In order to study the microsporogenesis of *A. exuvialis*, inflorescences at different stages of development were fixed in glutaraldehyde and embedded in glycol methacrylate. Sections of 1–2 μm were cut using an ultramicrotome and then stained with toluidine blue.

RESULTS AND DISCUSSION

A. Microsporogenesis

A. exuvialis produces flowers over a prolonged period of time (October to April) and inflorescences at different stages of development can be found on the same tree. Fig. 1 shows a very young anther in which the sporogenous tissue has not yet formed. Fig. 2 shows the dividing microspore mother cells. Eight microspore

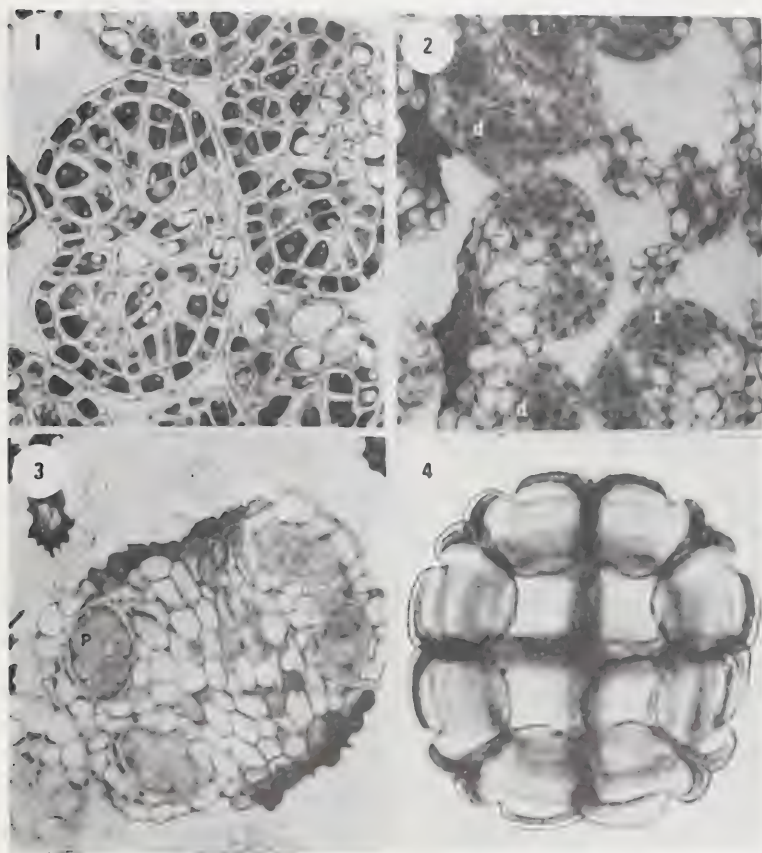


FIG. 1-3.

Part of a section through a young inflorescence of *Acacia exuvalis* showing: 1, very young anthers; 2, microspore mother cells after the first meiotic division of the nucleus, and tetrads; 3, polyads in the anther lobe.

d = diad; p = polyad; t = tetrad.

FIG. 4.

A light micrograph of a polyad of *A. exuvalis*.

mother cells are formed in each anther—four in each lobe. The four mother cells in a lobe are separated transversely by sterile cells, unlike the continuous row of pollen mother cells in each of the two cylindrical locules of the anther lobe found in most other Dicotyledonous plants (Maheshwari, 1950). After meiosis, one tetrad is formed from each microspore mother cell (Fig. 2). Subsequent mitotic divisions within each tetrad then give rise to a 16 cell polyad so that, ultimately, eight polyads are formed in each anther (Fig. 3).

Acacia exuvialis is a member of the series Gummiferae and, as expected, the polyads of this species are grooved. The centrally situated monads have a Y-shaped groove with two outer ridges, while the peripherally situated monads have H-shaped grooves with three peripheral ridges like those of most other Gummiferae species (Fig. 5B).

B. The Anther

Maheshwari (1950) states that the greater part of the mature anther wall consists of the subepidermal layer (endothecium) of the anther wall, since the epidermis, as well as the inner cell layers, becomes crushed as the anther matures. He also states that, in these subepidermal cells, fibrous bands (ridges) stretching as far as the outer tangential walls are formed on the radial walls.

Scanning electron micrographs of the mature anther wall show the remains of the epidermal cells and the corrugated outer walls of the endothelial cells (Fig. 6C). These corrugations are caused by the mentioned ridges stretching over the tangential walls as well.

The anthers of all South African *Acacia* species except *A. albida* have glandular appendages. Figure 6D shows a scanning electron micrograph of a young anther gland of *A. kirkii* with the secretion between the cells. In older glands the secretion has dried up and the cells appear very prominent.

C. The Polyads

Prior to this study, *Acacia* pollen has been studied largely under the light microscope which shows clearly the cellular structure of the polyads (Fig. 4). Little detail of the surface structure of the polyads, however, is visible.

With the aid of the scanning electron microscope much greater detail of the surface structure of the polyads can be seen.

Polyads with ungrooved monads:

Work with the scanning electron microscope confirms previous reports that the polyads of all the South African *Acacia* species which belong to the series Vulgares, as well as *A. albida*, have ungrooved monads. With the exception of *A. albida*, all of these polyads consist of 16 cells (Fig. 5A).

According to Van Zinderen Bakker and Coetzee (1959) there are 30 monads per polyad in *A. albida* and according to Guinet (1969) there are 16–30, but most

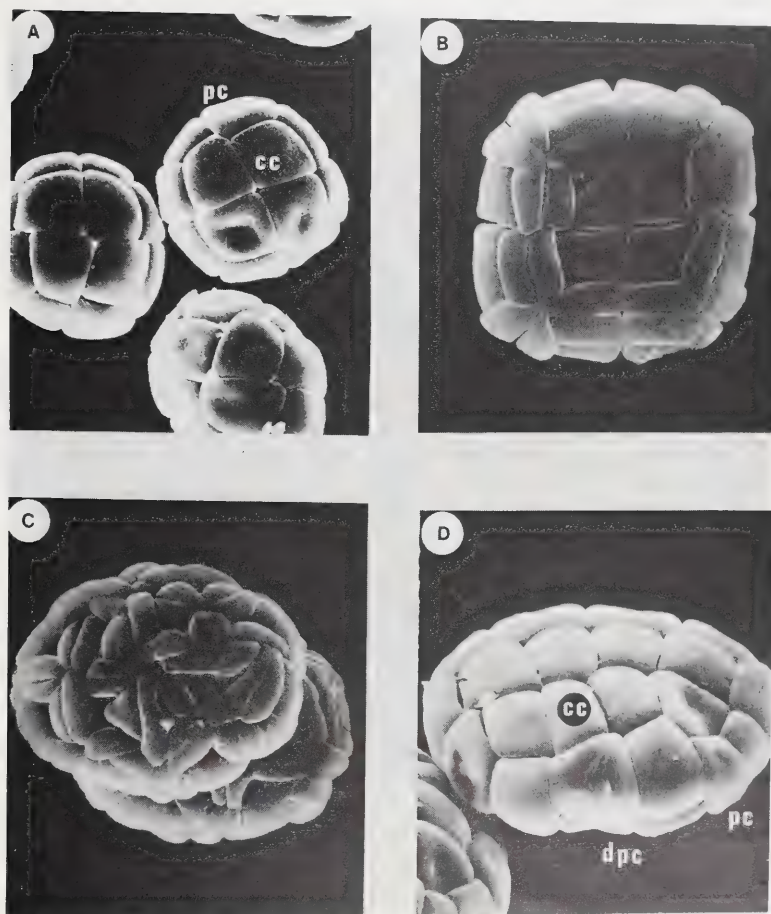


FIG. 5.

Scanning electron micrographs of polyads of

A. *Acacia hereroensis*, B. *A. borleae*, C. *A. giraffae* and D. *A. albida*.

cc = central cells; pc = peripheral cells; dpc = double layer of peripheral cells.

frequently 30. From Figure 5D it is evident that polyads can also consist of 32 cells. *A. albida* differs from all the other South African *Acacia* species in that two peripheral monads on each lateral side of a polyad undergo a single division to form a double layer, while the rest of the peripheral cells remain single. In the polyads of all other *Acacia* species (except *A. giraffae*) the peripheral cells occur in a single layer.

Polyads with grooved monads:

In pollen treated with acid, individual cells in the polyad are easily identifiable under the light microscope (Fig. 4). However, when the SEM is used, the grooves are so prominent that the ridges can easily be mistaken for individual cells (Fig. 5B).

This study further confirms previous observations that polyads of the South African acacias which belong to the series Gummiferae (except *A. giraffae*) consist of 16 cells, all of which are grooved (Fig. 5B, 6A and 6B). As in the case of the polyads of the Vulgares, the 16-celled polyad comprises a double layer of central cells (eight in total), surrounded by 8 peripheral cells. The polyads are usually very uniform in shape and extremely symmetrical. The surface structure is not very conspicuous but does show indentations (Fig. 6A and 6B).

According to Coetzee (1955) polyads of *A. giraffae* consist of 32 cells. Van Zinderen Bakker and Coetzee (1959) give the number of monads as 26–48 and Guinet (1969) as 16–32. Apart from the difference in the number of monads per polyad it is quite clear from Fig. 5C that the polyads of *A. giraffae* are different from those of other Gummiferae species. Without the aid of the light microscope it is not at all easy to distinguish the number of monads in scanning electron micrographs of *A. giraffae* polyads. Once the configuration of the cells has been determined (by light microscopy) the shapes of the grooved cells can easily be recognised under the SEM. In polyads of *A. giraffae* the monads are not clearly arranged in centrally- and peripherally-placed cells as in the other species of Gummiferae. The number of monads per polyad varies from 26–48. The monads are irregular in shape and have grooves varying from Y-shaped and H-shaped to X-shaped (Fig. 7). The ridges forming these grooves have a granular appearance.

DISCUSSION

Chevalier (1934) considered *A. albida* sufficiently different from other *Acacia* species to be placed in the monotypic genus *Faidherbia*. This new generic name has been retained by Guinet (1964 and 1969) on the basis of the anomalous pollen morphology of *A. albida*. Wickens (1969), too, has commented on the taxonomic position of *A. albida*, while Robbertse (in press) groups this species, together with *A. schweinfurthii*, *A. brevispica* and *A. kraussii* in “a some-



FIG. 6.

Scanning electron micrographs of polyads (A + B) and anther gland (D) of *A. kirkii* and a surface view of the endothelial cells from the anther of *A. giraffae* (C).
 e = remains of epidermal cell; s = secretion.

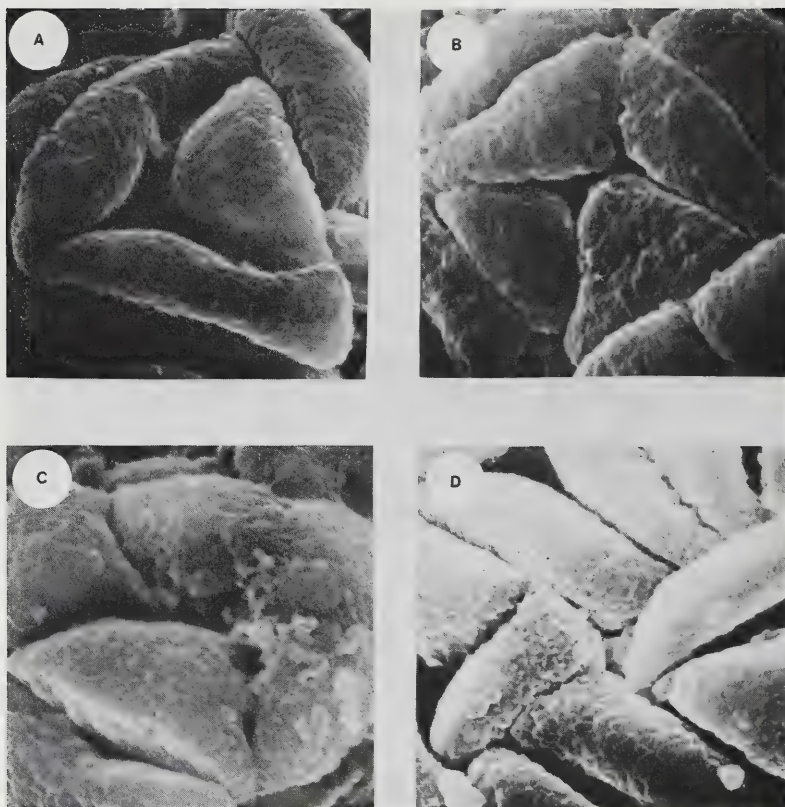


FIG. 7.

Scanning electron micrographs of monads from a polyad of *A. giraffae*, showing the structure of the monads.

A—monad with Y-shaped groove. B & C—monads with H-shaped grooves. D—granular structure of ridges.

what artificial" series (subgenus), *Farinosae*, on the basis of seed, seedling and flower morphology.

The degree of difference between the polyads of *A. albida* and those of the *Vulgares* species is, however, not greater than that between the polyads of *A. giraffae* and those of the rest of the *Gummiferae* species. For this reason and on the basis of other morphological criteria *A. albida* and *A. giraffae* must be seen as possible relicts of the parental stock of the remaining African *Acacia*

species rather than regarding *A. albida* as representing a completely distinct genus.

Scanning electron microscopy, as a technique, is a valuable aid to the plant morphologist. It should be regarded as an important supplement to light microscopy but cannot be used alone as a substitute.

ACKNOWLEDGEMENTS

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NOTES ON THE ALOES OF S. TROPICAL AFRICA WITH FOUR NEW SPECIES AND A NEW VARIETY

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ABSTRACT

Four new species of *Aloe* from Angola are described, together with a new variety of *A. andongensis* Bak.; their apparent relationships discussed and their positions in the Key to Reynolds, The Aloes of Tropical Africa and Madagascar (1966) are indicated. *A. esculenta* Leach is further discussed in the light of the discovery of an isotype specimen of *A. baumii* Engler & Gilg.

UITTREKSEL

AANTEKENINGE OOR DIE AALWYNE VAN S. TROPIESE-AFRIKA MET VIER NUWE SOORTE EN 'N NUWE VARIËTEIT

Vier nuwe *Aloe* soorte vanaf Angola word beskryf met 'n nuwe variëteit van *A. andongensis* Bak.; hulle klaarblyklike verwantskap bespreek en hulle posisies in die sleutel van Reynolds in "The Aloes of Tropical Africa and Madagascar" (1966) word aangedui. *A. esculenta* Leach word verder bespreek in die lig van die ontdekking van 'n Isotipe eksemplaar van *A. baumii* Engler & Gilg.

The three shrubby new species now described would fit into the key in Reynolds, Aloes of Tropical Africa & Madagascar (1966), under Group 19 (page 330) "Plants of shrubby growth" as follows:

- A. (c) 2. *Inflorescence simple* or 1-2-branched, 30-50 cm high; *leaves* strongly recurved, deeply concave; upper surface deep yellowish green, white-spotted in transverse bands, 20-30 cm long \times 7,5-9 cm broad; *racemes* cylindric acuminate \pm 20 cm long; *pedicels* 15-22 mm 129a *A. lepida*

The addition of another sub-division to "B" is required to accommodate *A. scorpioides* and *A. vallis*.

- B. (e) *Plants densely shrubby; inflorescence simple* or one-branched (very rarely 2-branched); *leaves* 20-30 cm long.
1. *Leaves* \pm 3 cm broad, yellowish green, unspotted; *racemes* erect, narrowly conic-acuminate, averaging 20 cm long; *pedicels* \pm 8 mm long 135c *A. scorpioides*
 2. *Leaves* \pm 4 cm broad, grey-blue to blue-green, maculate with small, circular or oval scattered whitish spots; *racemes* suberect or oblique, with the laterals widely diverging, elongate cylindric-acuminate, averaging 34 cm long; *pedicels* \pm 4 mm long 135d *A. vallis*

A. procera falls into Group 14; *A. Perianth* cylindric-trigonus (page 219), but will require an alteration to the "Inflorescence lead", as follows:

Inflorescence many branched, 1-2,75 m high and the addition under

(b) *Leaves* with dentate margins of:

5. *Inflorescence* 1,5-2,75 m high. *Racemes* lax, 25-40 cm long, *pedicels* averaging 3 mm long. *Perianth* reddish purple, 28-33 mm long 89a *A. procera*

Aloe lepidia Leach, sp. nov.; *A. andongensi* Bak. arctissime affinis sed sigillatim dissimilis foliis proportione latioribus, rigide valde recurvis, profunde late concavis vel canaliculatis, vivide flavo-atrovirentibus, supra maculis albidis conspicue fasciatis, dentibus marginalibus grandioribus; racemis plus minusve 2-plo longioribus laxissime florentibus; perianthio parum graciliore, ore latissime aperto, segmentis exterioribus brevius libris antherisque inclusis.

Frutex succulentus humilis e basi ramosus, plerumque c. 25–30 cm altus; caulibus erectis relative crassis, infra plus minusve nudis ad apicem foliorum rosula compacta coronatis. *Folia* valde patentia, rigide valde recurva, late ovata, attenuata, 20–28 cm longa, prope basin 7,5–9 cm lata; marginibus manifeste sinuato-dentatis, dentibus pungentibus deltatis, saepe aliquanto unciformibus, ad apicem brunneolis, 3–7 mm longis, 6–12 mm distantibus; *supra* basin versus plerumque leviter concava, superne profunde concava vel canaliculata, vivide flavo-atrovirentia maculis albidis conspicue irregulariter fasciata; *subtus* convexa flavo-atrovirentia maculis parvioribus basin versus confertioribus. *Inflorescentia* racemosa, 1 vel 2-ramosa, 30–50 cm alta. *Pedunculus* 6–12 cm longus, virellus epruinosis, basi aliquanto inaequaliter compressus, c. 10 mm latus. *Racemi* erecti, cylindrico-accuminati, plerumque c. 20 cm longi, 7–8 cm diam. aliquantum laxe florentes, gemmis mox nutantibus. *Bractae* ovato-acuminatae, 6–7 mm longae, 3–3,5 mm latae, exalbidae scariosae, 3-nervatae, nervis brunneolis. *Pedicelli* rubelli quam perianthium plerumque pallidiores, valde patentes, ad apicem cernui, 15–22 mm longi; *gemmis floribusque* inapertis aurantiaco-coccineis ad apicem viridi-brunneis. *Peranthium* dilute aurantiaco-coccineum, aliquanto lutescenti-vittatum, subtus pallescens, basi obtusum vel truncatum perbreviter stipitatum, cylindricum leviter curvatum, plerumque c. 25 (29) mm longum, prope basin perleviter ampliatum c. 5,5 mm diam., inde ad c. 4 mm leviter constrictum, illinc denuo ad 6 mm gradatim ampliatum, in ore luteolo 8–9 (11–12) mm diam.; *segmenta exteriora* per 5–6 mm libera, ad apicem recurva, nervis obscuris coccineis 3; *interiora* latiora obtusiora, marginibus aliquanto angustis, translucenti-albidis, obscurissime coccinei-nervatis. *Antherae* atro-testaceae inclusae. *Stigma* aliquando perbreviter exsertum. *Ovarium* pallide viride, anguste ovoideum plus minusve truncatum, c. 4 mm longum, 2–2,5 mm diam. *Capsula seminaque* non visa.

Typus: ANGOLA, Huambo Distr., *Baptista de Sousa s.n. sub Leach 14538A* (LISC, holo.; SRGH).

ANGOLA. Huambo Distr., Morro de Sume, \pm 27 km SSE ex Nova Lisboa, *Baptista de Sousa s.n.*, Hort. Hougard., prope Sinoia, Rhodesia, fl. 15. ii.1973, sub *Leach 14538A* (LISC; SRGH); *ibid.* Hort. Leach., Greendale, Rhodesia, fl. 14.v.1973, *Leach, Cannell & de Sousa 14538* (BM; PRE).



FIG. 1.

Aloe lepida Leach, from the Morro de Sume, Leach, Cannell & B. de Sousa 14538.

This most ornamental new species from near Nova Lisboa appears to be very closely related to *A. andongensis*; however, it differs significantly from that species in its proportionately wider, rigidly strongly recurved, deeply concave, dark yellowish green leaves which are conspicuously marked with irregular transverse wavy bands of whitish spots and armed with much larger marginal teeth. The laxly flowered, cylindric-acuminate racemes of *A. lepida*, while clearly showing a relationship with those of *A. andongensis*, are on average about twice as long and with buds more quickly nutant, are quite different in character from those of its relative; the open flowers of the new species are also rather more slender, with the outer segments free for only 5–6 mm, the mouth more widely open (up to 12 mm in diam.), the anthers included and the stigma only occasionally very shortly exserted. In vegetative characters there appears quite possibly to be a strong link also with *A. squarrosa* Bak. from Socotra; it is this kind of apparently reticulate relationship which has persuaded the author that the introduction into the classification of the genus, of the subspecies concept (with its evolutionary implications) would be both premature and unwise in view of our, as yet, so very incomplete knowledge at species level.

It seems to be worthy of note that specimens of both *A. andongensis* and *A. lepida* have retained their distinctive characteristics in cultivation, and in fact, have displayed remarkably little modification, even in respect of size.

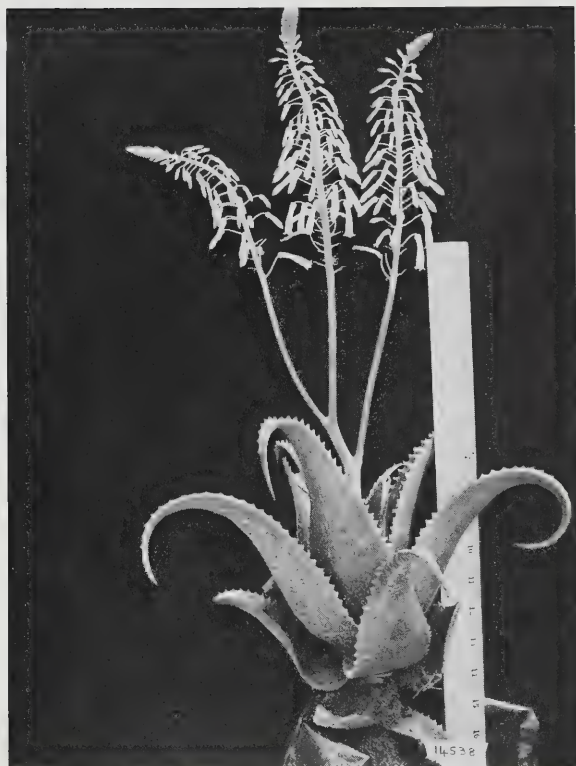


FIG. 2.

Aloe lepida Leach, the type plant flowering
in Mr. P. Hougard's garden near Sinoia, Rhodesia.

Distribution appears to be restricted to the Morro de Sume, some 27 km SSE of Nova Lisboa, where a remarkably morphologically homogeneous population occurs as rather scattered individuals on broken rock slopes in shade of heavily lichen clothed, dwarfed trees, in association with *A. metallica* Engler & Gilg (a previously unrecorded locality for this sp.). The site appears to be subject to frequent grass fires to which the new species seems to be rather less resistant than its associated congener.

This distribution is associated with the Cubango River system, as is that of *A. metallica*, rather than with the Cuanza and other westerly flowing rivers, as are all the known localities for the related *A. andongensis*.



FIG. 3.

A comparison of racemes of: Left: Typical *A. andongensis* Bak.
Right: *A. lepida* Leach, from the type plant.

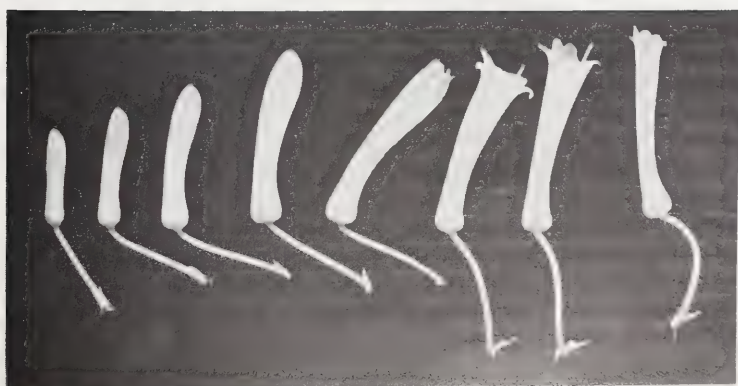


FIG. 4.

A. lepida Leach; Flowers 1:1.

Plant: a low succulent shrub, branching from the base, usually about 25–30 cm high; stems erect, relatively stout, more or less nude below and with a compact rosette of leaves at the apex. *Leaves* widely spreading, rigidly strongly recurved, broadly ovate attenuate, 20–28 cm long, 7.5–9 cm wide near the base; *margins* prominently sinuate dentate, with sharp, brown-tipped, deltate, often somewhat hooked teeth arising from a whitish base, 3–7 mm long, spaced 6–12 mm apart along the margins; *upper surface* usually slightly concave towards the base becoming more deeply so above and caniculate towards the apex, bright to dark yellowish deep green, conspicuously but irregularly marked with transverse wavy bands of whitish spots; *lower surface* convex, similar in colour but with more numerous, smaller, whitish spots more crowded towards the base. *Inflorescence* racemose, 1–2-branched, 30–50 cm high. *Peduncle* 6–12 cm long, greenish, sometimes tinged with brown, devoid of bloom, somewhat unequally compressed at the base, with the inner face only slightly convex, about 10 mm wide. *Racemes* erect, cylindric acuminate, usually about 20 cm long, 7–8 cm diam., rather laxly flowered, with the initially spreading buds very soon becoming nutant. *Bracts* ovate acuminate, 6–7 mm long, 3–3.5 mm wide, scarious, whitish, with 3 brownish nerves. *Pedicels* orange scarlet, usually paler than the perianth, widely spreading, cernuous at the apex, 15–20 mm long, becoming erect in fruit, with the buds and unopened flowers orange scarlet, green at the apex, becoming brownish. *Perianth* pale orange scarlet, somewhat yellowish striped, paler, often yellow on the underside; obtuse or somewhat truncate at the very shortly stipitate base, cylindric, slightly curved, averaging about 25 mm (up to 29 mm) long, slightly enlarged at the base, \pm 5.5 mm diam., then slightly constricted to about 4 mm, then again gradually enlarged to about 6 mm diam. below the 8–9 (10–12) mm diam., wide open, pale yellowish mouth; *outer segments* free for 5–6 mm, recurved at the apex, with 3 obscure scarlet nerves; *inner segments* more obtuse and broader than the outer, yellow, very obscurely orange scarlet nerved, with a rather narrow translucent whitish margin. *Anthers* included, dark terra-cotta with dark peach coloured pollen. *Style* very pale lemon with a whitish stigma, only occasionally very shortly exerted. *Ovary* pale green, more or less narrowly ovoid, somewhat truncate at the apex, \pm 4 mm long, 2–2.5 diam. towards the base, lightly 6-grooved, with 3 pale yellow stripes in the sinuses. *Capsule* and *seed* not seen.

Aloe scorpioides Leach, sp. nov.; *A. palmiformi* Bak. affinis sed habitu humiliore fruticosiore; foliis flavovirentibus persaepe immaculatis, marginum dentibus parvioribus; inflorescentiae pedunculo gracillimo patulo arcuato-ascendenti plerumque initio descendenti; racemis densius florentibus augustius acuminatis; bracteis grandioribus prominenter multi-nervatis; pedicellis brevioribus, gemmis floribusque inapertis suberectis; perianthio aliquanto breviori curviori valde differens.



FIG. 5.
Flowers 1:1, *Leach & Cannell 14654*.



FIG. 6.
Aloe scorpioides Leach, showing narrowly acuminate racemes, Ht. 0,85 m.
Leach & Cannell 14704.

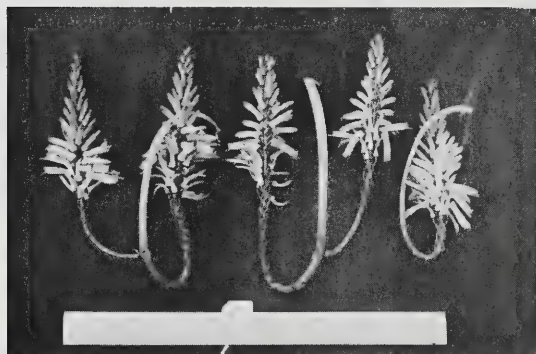


FIG. 7.

Aloe scorpioides, showing looped inflorescences. Reynolds 9275.

Frutex succulentus humilis foliosus, basi et superne ramosus, plerumque c. 0,5 m altus (rarissime usque ad 1 m); caulibus ramisque saepissime quaquaversus patentibus raro erectis, infra sublaxe foliatis ad apicem foliis 5–7 rosulatis. *Folia* patentia vel recurvula, angustissime ovato-attenuata usque ad 30 cm longa, basi 2,5–3,5 cm lata; marginum dentibus deltatis vel aliquanto unciformibus, flavidis vel brunneolis, 2–3 mm longis, 10–15 mm distantibus; folia inferiora amplexicaulia, internodiis striatis, 1–2 cm longis; *supra* perleviter concava, flavovirentia, immaculata; *subtus* convexa, virentia, obscure striata, plerumque immaculata, raro basin versus parciissime pallide parvi-maculata. *Inflorescentia* simplex vel 1– (rarissime 2–) ramosa. *Pedunculus* gracilis, viridis, glaber, haud pruinosis, superne plerumque brunneolus, initio patens, plerumque aliquanto vel interdum valde descendens deinde arcuato-ascendens, plerumque c. 15 cm longus; basi plano-convexus vel inaequaliter biconvexus, c. 10 mm latus, marginibus lateralibus acutis, superne in sectione transversali ovalis, c. 5 mm crassus, plerumque aliquot bracteis sterilibus infra racemos ornatus. *Racemi* erecti, plerumque c. 20 (11–25) cm longi (laterales breviores), c. 6 cm diam. prope basin, anguste conico-acuminati; gemmis floribusque inapertis suberectis, floribus apertis nutantibus. *Bracteae* pedicellos amplectentes, c. 6,5 mm longae, usque ad 3,5 mm latae, plus minusve ovato-subacutae vel acuminatae, prominenter multi-nervatae brunneolae. *Pedicelli* viridi-brunneoli, parce minute albo-maculati, c. 8 (6–10) mm longi. *Perianthium* coccineum, lutescenti-vittatum ubi apertum, inflme macula viridi ornatum, basi plus minusve obtusum perbreviter stipitatum vel truncatum, cylindrico-trigonum, plerumque c. 24 (21–28) mm longum, prope basin leviter ampliatum c. 7 mm diam., inde ad c. 5,5 mm leviter constrictum, illinc faucem versus denuo dilatatum usque ad 8 mm in ore aperto; *segmenta exteriora* per 6 (8,5–10) mm libera,

nervis obscuris coccineis 3, ad apicem brunnoelum confluentibus, marginibus lutescentibus; *interiora* latiora, late luteo-marginata, versus apicem brunnescentia, leviter carinata. *Antherae* non vel usque ad 2 mm exsertae. *Stigma* demum usque ad 2,5 mm exsertum. *Ovarium viride*, plus minusve obtuse trigono-ellipsoideum, c. 6 mm \times 2,75 mm. *Capsulae* raro effectae, tum plerumque aliquanto deformes; semina non visa.

Typus: ANGOLA, Moçâmedes Distr., Leach & Cannell 14654 (LISC, holo.; isotypi numerosi alibi conservati).

ANGOLA. Moçâmedes Distr., near Humbia, towards the base of the western escarpment of the Serra da Chela, Hort. Leach., fl. iv. 1973, Leach & Cannell. 14654 (BM; BR; K; LISC; LUA; LUAI; M; MO; PRE; SRGH); idem, Hort. Cannell., fl. iii.1972 (ZSS); near Vila Arriaga, Hort. Leach., fl. 24.iii.1972, Leach & Cannell 14704 (BOL), idem, fl. 8.iv.1973 (BR; NBG; SRGH); ibid. Hort. Cannell., fl. iii.1972 (B; COI); "Western slopes of the Serra da Chela, \pm 14 miles W of Sá de Bandeira", Hort. Leach., fl. 21.iv.1972, Reynolds 9275 (BM; LISC), idem, fl. iv.1973 (K; PRE; SRGH); "between Sá de Bandeira and Moçâmedes", Hort. Thompson., Magoeba's Kloof, fl. 22.v.1968 (PRE).

Note: There is some uncertainty regarding the precise localities of the last two specimens as "Western slopes . . ." would place the first in Moçâmedes Distr., while " \pm 14 miles W . . ." is high on the plateau in Huila Distr., and "between Sá de Bandeira and Moçâmedes" includes altitudes from 6 000' to sea-level with a corresponding range of ecological niches. However, on the available evidence it seems most probable that both were collected somewhere along the escarpment road leading down to Vila Arriaga.

In habit and slender arcuate-ascending peduncle with acuminate racemes with suberect buds, this new Angolan species most closely resembles *A. acutissima* H. Perr. from Madagascar, but it seems probable that the geographically adjacent *A. palmiformis* is, in fact, its closest relative. From this latter *A. scorpioides* differs significantly in a number of characters, most noticeably perhaps, in the development of its inflorescence. The much more slender peduncle of the new species is usually at first descending (sometimes almost vertically so), then arcuately ascending with the more densely flowered, more narrowly acuminate racemes held erect. This habit is sometimes developed to the extreme extent where the inflorescence completes a whole turn, with the racemes passing the descending peduncle on which they are borne. Other divergent characters are found in the suberect buds and unopened flowers, shorter pedicels, and generally shorter, curved flowers, while the larger prominently nerved, orange-brown bracts are quite distinctive: finally the plants are smaller, more scrambling and shrubby in habit, with yellow-green, almost invariably immaculate leaves with smaller marginal teeth.

Distribution appears to be restricted to the lower slopes of the Serra da Chela above Vila Arriaga, and near that village at the foot of the escarpment to the north-west of Sá de Bandeira, while its related congener occupies the rocky spurs and outcrops at higher altitudes on the plateau. The largest population found was growing on rock slopes not far from Vila Arriaga, where dense concentrations of plants cover relatively large areas in partial shade of mixed woodland. Elsewhere the colonies seen were smaller with plants usually scrambling on and among rocks in the open.

Variability appears to be limited mainly to the length and precise shape of the perianth, plants otherwise present a very uniform aspect. Leaf sap is particularly bitter in taste and when dry has a consistency not unlike that of the newly described *A. vallis* from further to the south on the same escarpment. Somewhat similar "crusty" sap appears to be common to several other Angolan species, including *A. andongensis*, *A. palmiformis* and the new *A. lepida* from Nova Lisboa.

Capsules are very sparingly developed in *A. scorpioides* and are then often somewhat malformed, while the anthers appear usually to be abortive, or if developing, to contain very little pollen. These characters, combined with the perianth variability, give rise to conjecture that the species may be hybrid in origin. It is difficult however, even to hazard a guess as to the possible parentage (apart possibly from *A. palmiformis*) from among the few species known to exist in the general area today, unless perhaps, the characters of *A. vallis* are very recessive; certainly a simple or one-branched inflorescence is common to both, as is also the relatively slender peduncle. However, despite these similarities as well as their low shrubby habit the two species do not otherwise have the appearance of being closely related, while *A. scorpioides* appears to be more plentiful than either of the abovementioned species.

Plant: a low, leafy, succulent shrub, branched from the base and above, usually about 50 cm high (rarely up to 1 m); stems and branches usually widely spreading in all directions, only rarely erect, subclaxly foliate below with a rosette of leaves at the apex. *Leaves* spreading or somewhat recurved, very narrowly ovate-acuminate, up to 30 cm long, 2.5–3.5 cm (averaging ± 3 cm) wide near the base; margins armed with deltate or somewhat forwardly hooked, yellowish or brownish tipped, pungent teeth, 2–3 mm long and 10–15 mm apart, the lower leaves basally sheathing with the striate internodes 1–2 cm long; *upper surface* very slightly concave below, flat or sometimes slightly convex above, yellowish green unspotted; *lower surface* strongly convex, rather darker than the upper surface, obscurely striate, usually immaculate, only rarely very sparingly spotted towards the base. *Inflorescence* simple or 1 (2)-branched. *Peduncle* slender, glabrous, green, not at all pruinose, becoming brownish above, at first spreading, then often, if not usually, somewhat descending,

sometimes strongly so, then arcuately ascending with the racemes held erect, generally about 15 cm long, plano-convex or unequally biconvex at the 10 mm wide base, with acute, sometimes wing-like lateral margins, soon becoming oval in cross-section to terete above, ± 5 mm thick, usually with a few sterile bracts below the racemes and the branches clasped at their base by a large attenuate many-nerved bract below and another similar but \pm truncate above. *Racemes* erect, averaging 20 (11–25) cm long (the laterals usually shorter), ± 6 cm diam. towards the base, narrowly conical or cylindric-acuminate, with the buds and unopened flowers suberect and the open flowers becoming nutant. *Bracts* clasping the pedicels, more or less ovate, subacute or acuminate, $\pm 6,5$ mm long, up to 3,5 mm wide, orange-brown, prominently dark brown multi-nerved (mostly ± 5), the nerves raised and sometimes appearing to be somewhat crisped. *Pedicels* greenish brown, sparingly minutely white flecked, ± 8 (6–10) mm long. *Perianth* scarlet, yellow striped in open flowers, with a rather conspicuous green blotch at its base, averaging ± 24 (21–28) mm long, cylindric trigonous, more or less obtuse at the base, very shortly stipitate or sometimes truncate, slightly inflated around the ovary, ± 7 mm diam. then slightly constricted to about 5,5 mm enlarging again towards the throat, more sharply but only slightly constricted just below the wide open mouth ± 8 mm across; *outer segments* free 6 (8,5–10) mm, obscurely 3-nerved (sometimes partly 5-nerved) with yellowish margins and the 3 nerves confluent at the brownish, spreading-recurved apex; *inner segments* slightly keeled towards the orange-brown apex, with broad, yellow to orange-yellow margins. *Filaments* palely translucent towards the base becoming yellowish above, with orange-brown, apparently usually abortive *anthers*; *pollen*, when present, peach coloured; *style* pale green, stigma whitish, at length exerted up to 2,5 mm. *Ovary* pale green, more or less obtusely trigonous, slightly tapering towards the apex, more or less ellipsoid, ± 6 mm \times 2,75 mm, 6-grooved, yellowish in the grooves. *Capsules* seldom developed, then usually somewhat misshapen; *seeds* not seen.

Aloe vallis Leach, sp. nov.; *A. gossweileri* Reyn. et *A. catengiana* Reyn. affinis sed habitu humiliore, rosulis foliorum caesio-viridium oblique portatis; inflorescentia simplici vel uniramosa; racemis c. 2-plo longioribus augustius acuminatis; floribus brevioribus, brevissime pedicellatis et perianthii segmentis exterioribus brevius libris ambobus valde differens.

Planta fruticosa, c. 30 (50) cm alta, e basi ramosa, foliorum rosulis terminalibus oblique portatis. *Folia* molliter carnosa, valde patentia, anguste ovato-attenuata, caesio-viridia vel caeruleo-grisea; illis rosulae 22–34 cm longis, 4–5 cm latis et usque ad 1,5 cm crassis basin versus; inferiora parviora distantia, internodiis dense albidomaculatis; *supra* leviter convexa vel plus minusve plana,

sparsim albido-maculata basin versus, maculis parvis ovalibus vel circularibus; *subtus* valde convexa, copiosius maculata; *marginēs* angustiores flavescētes, dentibus pungentibus flavidis deltatis, 2,0–2,5 mm longis, c. 10–12 mm distantibus armati, interstitiis plus minusve rectis. *Succus* foliorum flavido-opacus crustaceus. *Inflorescentia* simplex vel divaricate uniramosa, suberecta vel obliqua, ex rosula foliorum procurrens, 50–60 cm longa. *Pedunculus* gracilis, basi plano-convexus, viridis, saepe brunneo-vittatus, superne teres, brunneo-purpurascens. *Racemi* anguste elongate cylindrico-acuminati, laxe floriferi, gemmis floribusque inapertis valde patulis, floribus interdum subsecundis, demum pendulis; *racemus terminalis* plerumque c. 32 (25–45) cm longus, *lateralis* 17–30 cm longus. *Bracteae* ovatae, acutae, scariosae, pallide brunneae albo-marginatae, nervis atro-brunneis 1–5, plerumque 3, usque ad 4,5 mm longae \times 2,5 mm latae. *Pedicelli* brunnei, 4,0–4,5 mm longi. *Perianthium* vivide rubrum, ad orem apertum lutescentia, 20–25 mm longum, leviter curvatum, fere cylindricum (vix trigonum), ad basim c. 5 mm diam., obtusum, supra ovarium paululum decrescens, inde ad 5,5 mm diam. gradatim dilatatum; *segmenta exteriora* per 4,5–6,0 mm libera, triplinervia; *interiora* latiora, obtusiora, triplinervia, ad apicem aurantiaco-lutescentia, marginibus latis pallidis translucētib. *Antherae* inclusae vel vix exsertae. *Ovarium* olivaceum, 6-sulcatum, obtuse trigonum, c. 5,5 mm longum, 2,5 mm diam. *Stylus* demum non vel perbreviter exsertus.

Typus: ANGOLA, Huila Distr., Leach & Cannell 14651 (LISC, holo.; etc.).



FIG. 8.
Aloe vallis Leach, flowers 1:1.

ANGOLA. Huila Distr., Serra da Chela escarpment, cliffs west of Tchivinguiro, \pm 1 230 m alt., Hort. Leach., fl. 23.iv.1973, Leach & Cannell 14651 (BM; BR; K; LISC; LUAI; M; MO; PRE; SRGH; WIND), idem fl. 11.xi.1972 (ZSS), idem, Hort. Cannell., fl. v.1972 (LUA), idem, young raceme, 14.iv.1973 (LISC).



FIG. 9.

Aloe vallis Leach, flowering at Fort Victoria.



FIG. 10.

Aloe vallis Leach, terminal raceme.

This most distinctive species appears to be most closely related to *A. gossweileri* and *A. catengiana* but differs markedly from both in being a very shrubby plant of relatively dwarf stature, with rosettes of grey-blue to blue-

green leaves tilted to one side, and a simple or 1-branched inflorescence with more narrowly acuminate racemes which are usually about twice as long, or more, as those of its relatives; while the shorter flowers, of which the outer segments are free for only 4.5–6.0 mm are carried on pedicels only half the length of those of either. Additionally the new species differs from *A. catengiana* in its bright scarlet flowers. As to habit *A. vallis* may perhaps approach most closely to *A. hildebrandtii* Bak., from Somalia, and in leaf colour and texture to *A. flexilifolia* Christian, from Tanzania; it is, in fact, not entirely dissimilar from this latter species in habit also, but is essentially a smaller plant differing completely in most other respects, while the young racemes are drooping after the manner of those of *A. deserti* Engl.

Plants form dense clumps, sometimes hanging from rock shelves of cliffs of the western escarpment of the Serra da Chela, at about 1 230 m altitude, a few miles to the west of Tchinguero.

Plant shrubby, 30–50 cm high, branched from the base, with the terminal rosettes of leaves tilted to one side. *Leaves* fleshy, rather softly textured, with a thin, greyish or greenish blue to blueish green cuticle, narrowly ovate-attenuate; those of the rosette 22–34 cm long, \pm 4–5 cm wide and up to 1.5 cm thick towards the base; *upper surface* slightly convex or more or less flat, with a few small, oval or circular, whitish spots towards the base; *lower surface* strongly convex and more freely spotted; the smaller, more widely spaced, amplexicaul lower leaves, copiously spotted on the internodes; *margins* very narrow, yellowish, with yellowish, orange or orange-brown tipped, deltate pungent teeth, 2.0–2.5 mm long, more or less regularly spaced, \pm 10–12 mm apart, with the interspaces more or less straight. The *leaf sap* is very distinctive: of a frothy consistency when wet, it becomes an opaque crystalline yellow crust on drying, with an appearance rather like flowers of sulphur when crushed. *Inflorescence* simple or divaricately one-branched from low down, obliquely or suberectly out-thrust from the rosette of leaves, 50–60 cm, or more, long. *Peduncle* slender, plano-convex at the base, dull green often streaked with brown, becoming terete, purplish brown above, with a few many-nerved, brownish, white margined scarious, sterile bracts, the longest subtending the lateral branch \pm 20 mm long. *Racemes* rather laxly flowered, narrowly elongate cylindric-acuminate, the terminal mostly \pm 32 (25–45) and the lateral 17–30 cm long respectively, about 4 cm diam. with the buds and unopened flowers widely spreading, later and when open, becoming pendulous and sometimes subsecund with the uppermost lying more or less flat along the top of obliquely produced racemes. *Bracts* dry, scarious, pale brown with broad white margins, with 1–5, mostly 3, dark brown nerves, ovate acute, up to 4.5 mm long \times 2.5 mm wide. *Pedicels* brown, 4.0–4.5 mm long. *Perianth* bright scarlet, somewhat purplish at the apex, becoming yellowish at the mouth in open flowers, 20–25

mm long, slightly curved, more or less cylindric (scarcely trigonous), \pm 5 mm diam. at the obtuse, scarcely stipitate base, narrowing slightly to \pm 4,5 mm above the ovary, thence again widening to \pm 5,5 mm diam. at the open mouth; *outer segments* free 4,5–6,0 mm, with 3 brownish nerves confluent at the apex; *inner segments* wider and more obtuse than the outer, with pale, translucent, wide margins and 3 brownish nerves confluent at the orange-yellow apex. *Filaments* yellowish, filiform flattened, the 3 inner narrower and lengthening before the three outer, with the anthers not or scarcely exerted. *Ovary* olive-green, yellowish on the angles, 6-grooved, somewhat reddish 3-striped, obtusely trigonous, \pm 5,5 mm long \times 2,5 mm diam. towards the base, tapering slightly towards the apex; *style* straw coloured with the stigma not or only very shortly exerted. *Capsule* and *seed* not seen.

Aloe andongensis Bak. var. *repens* Leach, var. nov.; a varietate typica caulibus repentibus saepe 60 cm longis longioribusve, e basi et superne ramosis; rosulis foliorum parviorum proportione angustiorum; inflorescentia pedunculo ramisque gracilioribus; ovario brunneo-aurantiaco differt.

Typus: ANGOLA, Cuanza Sul Distr., *Leach & Cannell 13950* (BM; BR; K; LISC, holo.; PRE; SRGH).

ANGOLA. Cuanza Sul Distr., without precise locality, cult. & fl. at Nelspruit, Transvaal, 10.vi.1967, *Reynolds* sub *Leach 12899* (LUA; LUAI); \pm 11 km E of Gabela, on granite hill in association with *Euphorbia atrocarmesina* Leach, *Huernia volkartii* Wederm. & Peitsch., cult. & fl. at Greendale, Rhodesia, 8.vi.1973, *Leach & Cannell 13950* (BM; BR; K; LISC; PRE; SRGH).

This new variety occurs on the slopes of rounded granite hills in the vicinity of Gabela. It was at first thought to be merely a depauperate form of the typical variety; however, plants have retained their characteristics in cultivation over a number of years and under a variety of conditions, at Mbabane, Swaziland, in the late Dr. Reynold's garden, at Nelspruit, Transvaal, and at Greendale, Rhodesia. Specimens of the typical variety have likewise retained their characteristics; it seems therefore, that the constant divergencies noted have a genetic basis and that the smaller creeping plants should receive taxonomic recognition.

Var. *repens*, as the epithet implies, has a prostrate habit, with stems up to 60 cm or more long, which branch freely from the base and above, so that plants form large spreading clumps. The stems are foliate for the greater part of their length, with much smaller, proportionately narrower and more widely spreading leaves than those of var. *andongensis*; these are armed with smaller, more crowded marginal teeth and are more copiously white-spotted with a tendency for the spots to be arranged in wavy transverse bands. There is little difference in the inflorescence of the new variety, apart from the more slender peduncle and branches, and the brownish orange colour of the ovary.



FIG. 11.

Aloe andongensis Bak. var. *repens* Leach. Leach & Cannell 13950.

Aloe procera Leach, sp. nov.; *A. guerrae* Reyn. affinis sed foliis pallidioribus tenuioribus, pro parte apicali plerumque usque ad $\frac{2}{3}$ per totam longitudinem marcescentibus brunnescentibus, dentibus marginalibus parvioribus; inflorescentia elatissima, supra medium ramifera; racemis longioribus laxius florentibus; floribus purpureis aliquanto brevioribus gracilioribus, plerumque subretrorsis, pedicellis brevioribus; bracteis parvioribus paucinerviis satis diversa.



FIG. 12.

Aloe procera Leach, flowers 1:1.

Plantae solitariae, succulentae, plerumque breviaules, caule usque ad c. 25 cm alto. *Folia* c. 20, dense rosulata erecto-patentia ad apicem perleviter recurva, ovato-attenuata, tenuia, pallide viridia, obscure lineata, immaculata, plerumque parte apicali, usque ad $\frac{2}{3}$ per totam longitudinem, brunnescentia siccata marcidaque, basi 8–9,5 cm lata, usque ad c. 55 cm longa parte marcida inclusa; *marginibus* dentatis, angustissime pallide luteo-cartilagineis, dentibus pungentibus plerumque deltatis, interdum uncinatis, basi pallidis apice breviter testaceis, 1,5–3,5 mm longis, 10–18 mm distantibus; *supra* basi plus minusve plana superne perleviter canaliculata; *subtus* basi perleviter convexa fere plana, superne leviter convexa. *Inflorescentia* elata 2,2 m (usque ad 2,75 m), paniculata, pruinosa floribus inclusis, supra medium 9–12 ramosa; *pedunculus* superne viridulus teres, basin versus brunnescens, inaequaliter biconvexus marginibus lateralibus cartilagineis, acutis, saepe fere aliformibus, basi c. 4 cm latus \times 2,25 cm crassus; *rami* oblique saepe fere horizontaliter patuli (racemo terminali incluso), usque ad 55 cm longi, infra racemum aliquot bracteis sterilibus muniti, basi bracteis 2 arcte amplexantibus instructi; inferiore usque ad 2 cm longa \times 1 cm lata, plurinervi; *superiore* simili sed irregulariter truncata, 4–5 mm longa. *Racemi* 25–40 cm longi, plerumque coma parva laxa bractearum siccaram

apice ornati; gemmis floribusque secundis aliquanto retrorsis, floribus paucis unquam apertis tum plerumque valde retrorsis; *bractae* deltatae, attenuatae, scariosae, plerumque 3-nervatae, brunnescentes, 5–6 mm longae, c. 4 mm latae; *pedicelli* 1,5–5 mm longi. *Perianthium* purpureum, 28–33 mm longum, 5–6 mm diam., basi obtusum vel truncatum, haud stipitatum, cylindrico-trigonum rectiusculum, supra ovarium leviter lateraliter compressum distincte trigonum; *segmenta exteriora* per 9–11 mm libera, apice subacuta leviter patentia, c. 3,5 mm lata, marginibus pallidioribus; nervis 3, atro-purpureis ad apicem confluentibus; *interiora* obtusiora, latiora (usque ad 6,5 mm), obscure 3-nervata leviter obtuse carinata, marginibus latioribus pallidioribus apicem versus albescentibus, supremo valde patenti recurvo, lateralibus paululum patentibus. *Antherae* atroarmeniaca deinceps breviter exsertae. *Ovarium* atroviride aliquanto anguste olliforme, c. 7 mm longum \times 3,5 diam. *Stylus* pallide stramineus demum usque ad 6 mm exsertus. *Semina* plus minusve oblonga, fusca, c. 12,5 mm \times 5,0 mm, inaequaliter 3-alata, alis membranaceis exalbidis.

Typus: ANGOLA, Cuanza Sul Distr., L. C. Leach & I. C. Cannell 14617 (LISC, holo.; SRGH).

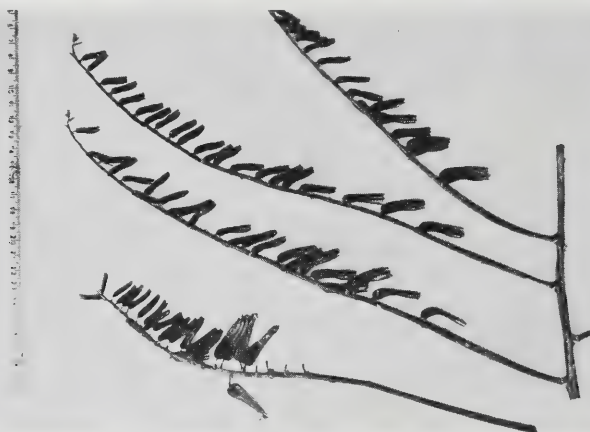


FIG. 13.

Comparison of racemes: *A. procera* above; *A. guerrae* below.

ANGOLA. Cuanza Sul Distr. \pm 50 km N of Quibala, approx. 10°20'S: 14°51'E, alt. \pm 1 230 m, steep hillside in deciduous woodland, Hort. N. D. Bey, Salisbury, fl. 12.vii.1972, Leach & Cannell 14617 (LISC; SRGH), *ibid.*, 14617A (BM), *ibid.*, Hort. I. C. Cannell, Fort Victoria, fl. 6.viii.1972, 14617B (K; PRE).

In common with the recently described *A. luapulana* Leach, this new Angolan species seems to find its nearest relatives among members of the group con-



FIG. 14.

Mr. I. C. Cannell with typical plant, 50 km N of Quibala.
Aloe procera Leach.

taining *A. christianii* Reyn. and *A. pretoriensis* Pole Evans, while it is obviously most closely related to *A. guerrae* of this affinity. *A. procera* differs from this latter in its thinner, paler green leaves with smaller marginal teeth and the apical portion dry and withered; in leaf characters the new species is very close indeed to *A. luapulana* but is otherwise quite different. More important differential characters by which *A. procera* is distinguished from *A. guerrae* lie in its remarkably tall inflorescence which is branched above the middle and bears longer, more laxly flowered racemes of subretrorse, rather smaller, purple flowers, borne on pedicels only about half the length of those of *A. guerrae* and subtended by smaller, few nerved bracts.

This interesting new species is known only from the type locality where it might have remained undiscovered but for a recent fire which had cleared the undergrowth and tall grass sufficiently for plants to be noticeable from the road. Plants, although locally plentiful, occur only as scattered individuals among tall grasses in deciduous woodland and are frequently, although apparently not necessarily, closely associated with the termite mounds which abound on the red clayey soil of the steep hillsides of their habitat.

The tall inflorescence of this species, which is matched in height only by those of *A. christianii* and *A. pretoriensis*, among the more or less acaulescent species of Africa, is all the more remarkable in view of the relatively small size of the plants from which it is produced.

A small plant, flowering for the first time at the Botanical Research Institute, Pretoria, bore a l-branched inflorescence about 1,7 m high, with racemes erect, and flowers evenly distributed around the axes. As a similar tendency in respect of the terminal racemes appears occasionally to occur in older plants it seems possible that "racemes oblique" may be, to some extent, a character acquired with age.

Plants solitary, succulent, acaulescent or usually shortly caulescent, with a short, stout stem, up to ± 25 cm high, with the rosette held erect. *Leaves* about 20, densely rosulate, erectly spreading, very slightly recurved at the apex, ovate-attenuate, thin, scarcely fleshy, pale green, obscurely lineate, unspotted, usually with the apical portion (up to 2/3rds their length) becoming brown, dry and withered, 8–9,5 cm broad at the base, up to 55 cm long, including the withered apical portion; *margins* extremely narrow cartilaginous, pale yellowish, armed with sharp, deltate or occasionally hooked teeth, the colour of the margin at their base; shortly orange brown tipped, 1,5–3,5 mm long, 10–18 mm apart along the margin, generally more crowded towards the base of the leaf; *upper surface* more or less flat low down, becoming slightly canaliculate above; *lower surface* very slightly convex near the base becoming somewhat more so towards the apex. *Inflorescence* paniculate 2,2 m (up to 2,75 m) tall, 9–12 branched above the middle, heavily pruinose including the flowers; *peduncle* terete above, greenish becoming brownish towards the unequally biconvex base, with the lateral margins cartilaginous, sharp and almost wing-like, ± 4 cm wide \times 2,25 cm thick near the base; *branches* obliquely, often almost horizontally spreading (usually including the terminal raceme), up to 55 cm long, the lowermost with up to two branchlets which are sometimes held erect; with a few sterile bracts below the racemes and tightly clasped at their base by a pair of many nerved brownish bracts, the lower narrowly triangular, up to 2 cm long \times 1 cm wide, the upper similar but irregularly truncate and only 4–5 mm long. *Racemes* 25–40 cm long, usually with a small lax coma of dry bracts at their apex; buds and flowers secund, somewhat retrorse with

the open flowers (few at any one time) strongly so; *bracts* deltate attenuate, scarious, brownish with 3 raised brown nerves (sometimes supplemented by an obscure usually incomplete nerve on each side), 5–6 mm long \times 4 mm wide; *pedicels* the colour of the perianth, 1.5–5 mm long, averaging about 3 mm. *Perianth* dull reddish purple, 28–33 mm long, 5–6 mm diam., obtuse or truncate at the base, not at all stipitate, cylindric-trigonus, fairly straight, slightly laterally compressed above the ovary and becoming distinctly trigonus; *outer segments* free for 9–11 mm, slightly spreading at the subacute apex, \pm 3.5 mm wide with paler rosy margins; with 3 dark purple nerves becoming confluent at the apex; *inner segments* more obtuse and wider (up to 6.5 mm) than the outer, obscurely 3-nerved, slightly obtusely keeled, with wide pale margins becoming whitish towards the apex; the uppermost segment strongly spreading recurved at the apex but the laterals only very slightly so. *Anthers* rich orange brown, in turn shortly exerted. *Ovary* rather dark dull green, slightly barrel shaped, \pm 7 mm long \times 3.5 mm diam. *Style* pale straw coloured, at length exerted up to 6 mm. *Capsule* ellipsoid, shallowly 6-grooved, dull green, \pm 3 cm \times 1.5 cm diam., borne on a short pedicel 6 mm long (apparently lengthened only slightly). *Seeds* more or less oblong, dull light brown, \pm 12.5 mm long \times 5 mm wide, unequally 3-winged, with whitish membranaceous wings.

A. procera would “Key out” in Reynolds, *Aloes of Tropical Africa and Madagascar*: 219 (1966), under Group 14,A(b), being distinguished by:

Racemes sublux to lax, 25–40 cm long; *Pedicels* 1.5–5.0 mm long;

Perianth dull purple, 28–33 mm long.

Also, of course, by its very much taller inflorescence.

***Aloe esculenta* Leach**, in *Jl S. Afr. Bot.* **37**: 249 (1971).

When publishing this species the possibility was discussed that the correct name might be *A. baumii* Engl. & Gilg, but that in the absence of any material, the photograph in Warburg, Kunene-Sambesi Expedition: t.90 (1903) must, of necessity, be accepted as portraying *A. baumii*, and its synonymy with *A. zebrina* Bak. consequently also accepted.

Subsequent to the publication of *A. esculenta* I was informed by Mr. B. L. Burt of the Royal Botanic Gardens, Edinburgh (E), that a duplicate of *Baum* 275 existed in that herbarium. This specimen was kindly sent on loan to the Government Herbarium, Salisbury, Rhodesia (SRGH), for my examination.

Unfortunately this material is a mixture of two quite different species and serves only to confirm the confusion which exists in relation to the identity of *A. baumii*.

Mounted on the sheets are two inflorescence branches only, with all the flowers detached and loose in a capsule. There are no leaves. The bracts subtending the pedicels on these branches are \pm 10 mm or less in length, thereby

indicating *A. zebrina* as being the probable source of the specimen (this measurement agrees with that given by Engler & Gilg for the bracts of *A. baumii*). However, on counting the loose flowers and buds it was found that there are 109 of these but only 46 pedicels on the apparently complete, supposedly corresponding inflorescence branches. Some of the flowers are a good match for those of *A. esculenta*, while others have the basally inflated perianth of those of *A. zebrina*; also loose in the capsule are two only bracts which are very much larger than those of the inflorescence branches of the specimen, these are ± 20 mm long and correspond well with those of *A. esculenta*.

How, when or where the mixture occurred is a matter for speculation but it seems possible that the description may be as much a mixture as is the material. However, since the major portion of the material appears to belong to *A. zebrina* rather than to *A. esculenta* and the locality given on the collector's label coincides with that of the photograph (a locality where, as far as is known, *A. esculenta* does not occur), which photograph appears definitely to depict *A. zebrina*, it seems that the nomenclatural position regarding *A. baumii* remains as outlined in the Journal of S. African Botany *l.c.*, and that it should, therefore, continue to be regarded as synonymous with *A. zebrina*.

The puzzle of the October flowering of *Baum* 275 remains, as this date is confirmed by the information given on the collector's label attached to the Edinburgh sheet.

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The late Dr. G. W. Reynolds for living plants of *A. scorpioides*, *A. andongensis* var. *repens* and of some related species.

The South African Council for Scientific and Industrial Research for generous financial support in respect of my first Angolan expedition.

THELYPTERIDACEAE OF AFRICA AND ADJACENT ISLANDS

R. E. HOLTUM

ABSTRACT

An attempt is made to provide a systematic account of all known species in the fern-family Thelypteridaceae in the whole of Africa and in adjacent islands in the Indian and Atlantic oceans. The species are arranged in the system of Old World genera proposed by the author in Blumea 19: 17-52 (1971), with the object of showing the relationships of African species to those in Asia. Two groups of African species however have their nearest relatives in the New World and were not dealt with in the paper of 1971; these are the genus *Amauropelta*, and a new section *Palazoneuron* in the genus *Christella*. In some cases the adoption of the segregate generic names has involved the substitution of other specific epithets in place of those which are correct in *Thelypteris* and *Cyclosorus* as recognized in most recent works on African ferns.

Two interesting new cases of the relationship between the floras of the islands in the Gulf of Guinea and those in the Indian Ocean are mentioned: *Metathelypteris fragilis*, only known from one collection in Madagascar and one in S.Tomé; *Sphaerostephanos elatus*, well known in the Mascarene Islands, now reported with a new subspecies in S.Tomé. Seven new species are described.

UITTREKSEL

THELYPTERIDACEAE VAN AFRIKA EN OMLIGGENDE EILANDE

'n Poging word aangewend om 'n sistematiese verslag van al die bekende soorte van die varingfamilie Thelypteridaceae in die hele Afrika en omliggende eilande in die Atlantiese en Indiese oseane daar te stel. Drie soorte word geplaas in die sisteem van Ou Wêreld genera voorgestel deur die skrywer in Blumea 19: 17-52 (1971) met die doel om die verwantskappe tussen soorte uit Afrika en Asië aan te toon. Twee groepe soorte uit Afrika se naaste verwante kom egter in die Nuwe Wêreld voor en was nie in 1971 behandel nie; dit is die genus *Amauropelta* en die nuwe seksie *Palazoneuron* in die genus *Christella*. In sommige gevalle het die aanname van onderskeidende generiese name die vervanging van ander soort name genoodsaak in die plek van die wat korrek is in *Thelypteris* en *Cyclosorus* soos erken in die jongste werke oor die varings in Afrika.

Twee interessante gevalle van verwantskap tussen die floras van die eilande in die Golf van Guinea en die in die Indiese osean word genoem: *Metathelypteris fragilis*, van een versameling in Madagaskar en een in S. Tomé; *Sphaerostephanos elatus* wel bekend in die Maskarene-eilande nou gevind met 'n nuwe subspesie in S. Tomé. Sewe nuwe soorte word beskryf.

This paper is complementary to one published in 1971 (Blumea 19: 17-52) in which I gave a conspectus of 23 genera of Thelypteridaceae in the Old World, but noted (p. 18) that there were some African species which appeared to have relatives in America and not in Asia. Since 1971 I have attempted to compile information on the species of this family in the Mascarene Islands, and in so doing have looked at all species in Africa and neighbouring islands in the Atlantic and Indian Oceans. I believe that I can now allocate all African species

to species-groups, though two of the groups cannot be defined clearly until all the American representatives have been recognized (*Amauropelta* and *Parathypteris*).

The total number of species in Africa and the islands, as here presented, is 55; in mainland Africa 34. This compares with 450–500 for Asia, Malesia and the Pacific (including many still undescribed). In dealing with this much more prolific region, I felt obliged to follow the lead of R. C. Ching (*Acta Phytotax. Sinica* 8: 289–335; 1963) in recognizing a number of genera, for two reasons. The family is very polymorphous in Asia-Malesia, and extreme forms of various kinds are so different from each other that their segregation in separate genera appears appropriate, though there are also a large number of species which show less obvious differences. The other reason is that in naming a species in such a large assemblage it is necessary to give some indication of its relationships, and this is most easily done by recognition of separate genera. Ching dealt with the species of mainland Asia, but did not realize the magnitude of the problem presented by the far greater diversity in Malesia. Published descriptions of species in Malesia did not indicate any clear division into species-groups, and I decided that it was necessary to look for and describe characters hitherto ignored. I found that characters of sporangia and spores appeared to be particularly important, also details of the character and distribution of glands and hairs. Having thus looked at and re-described almost all types of published species, and also a very large number of other specimens, including some extensive recent collections, I devised a new classification, based on Ching's but considerably elaborated in various ways. Though it cannot be final, I believe that this classification does give significant information about natural groups of species and their distribution. One conclusion from this intensive study is that the classification adopted in Copeland's *Genera Filicum* (1947) is untenable in its separation of the genera *Lastrea* and *Cyclosorus* on the character of free or united veins; there are several natural species-groups which have some members with free and some with united veins. Therefore it appears to me that there are only two practicable alternatives: to include all Thelypteridaceae (perhaps 1 000 species) in one genus *Thelypteris*, or to recognize a number of different genera. For the large number of species in Asia-Malesia the latter course seemed to me imperative. I have therefore adopted it here also, for comparative purposes, for the species of Africa; but for persons who are concerned only with Africa, or a part of Africa, it is reasonable to adopt one genus *Thelypteris*, as Prof. Schelpe has done in his account of the ferns in *Flora Zambesiaca*.

Therefore in the present account I have set out the genera as I see them, and have included new combinations where these are called for, but I have also indicated the appropriate name in *Thelypteris* (in a few cases this has a specific epithet different from the correct one in the genus I adopt). It will be seen that

some African species, including those here described as new, still lack names in *Thelypteris*.

Under each species is cited the designated type, and its location if known (with ! to indicate that I have examined it), and also the types of basionyms regarded as synonyms. Each paragraph of a synonymy consists of names which are all based on the same type. Also cited are Prof. Schelpe's account of ferns in *Flora Zambesiaca*, and the recent works of Alston and Tardieu-Blot on the ferns of other parts of Africa.

KEY TO THE GENERA

- 1 Veins all free, or basal veins sometimes touching below the sinus between two pinna-lobes:
- 2 Fronds bipinnate, with free or \pm adnate pinnules:
 - 3 Slender septate hairs present on lower surface of frond-axes . . . 1. *Macrothelypteris*
 - 3 Slender septate hairs lacking:
 - 4 Sori indusiate; largest pinnae under 10 cm long 2. *Metathelypteris*
 - 4 Sori exindusiate; fronds much larger 3. *Pseudophegopteris*
- 2 Fronds simply pinnate with deeply lobed pinnae:
 - 5 Several pairs of lower pinnae gradually reduced:
 - 6 Caudex stout, erect 4. *Amauropelta*
 - 6 Caudex a slender creeping rhizome 5. *Parathelypteris*
 - 5 An abrupt transition to much-reduced pinnae at base of frond, or a few pairs lower pinnae gradually and not greatly reduced:
 - 7 An abrupt transition to much-reduced basal pinnae:
 - 8 Reduced pinnae very numerous; spores bearing many small wings of uniform size 6. *Pseudocyclosorus*
 - 8 Reduced pinnae 3-6 pairs; spores bearing less numerous wings of varying size 7. *Christella*
 - 7 A few pairs of pinnae gradually somewhat reduced, or no reduced pinnae:
 - 9 Sori exindusiate:
 - 10 Sporangia setose; basal veins not meeting at sinus:
 - 11 Sori running along veins; spores with many small wings 8. *Stegnogramma*
 - 11 Sori almost round; spores smooth or with a slight raised reticulum 3. *Pseudophegopteris*
 - 10 Sporangia not setose; basal veins meeting below a triangular sinus-membrane 4. *Amauropelta*
 - 9 Sori indusiate:
 - 12 Rhizome slender, long-creeping; fronds almost hairless beneath with broad scales on costae 9. *Thelypteris*
 - 12 Rhizome not slender; fronds always conspicuously hairy beneath, no scales on costae 7. *Christella*
- 1 At least the basal pair of veins regularly anastomosing with excurrent vein running to the sinus (in *Amphineuron* sometimes free on parts of a frond):
 - 13 Rhizome long-creeping; thin scales on lower surface of costae; no reduced basal pinnae 10. *Cyclosorus*
 - 13 Not this combination of characters:
 - 14 Exindusiate:
 - 15 Numerous buds on rachis resulting in much proliferation; forked hairs present on rachis 11. *Ampelopteris*
 - 15 At most one bud on rachis; no forked hairs:
 - 16 Pinnae to 1 cm wide; spores subspherical, minutely papillose 12. *Menisorus*
 - 16 Pinnae on mature plants much wider; spores otherwise 13. *Pneumatopteris*

14 Indusiate:

- 17 Yellow or whitish capitate hairs abundant at least along distal parts of veins of lower surface; sori confined to pinna-lobes

14. *Amphineuron*

17 Not this combination of characters:

18 Sporangia setose:

- 19 Lower surfaces conspicuously hairy; c. 6 pairs of small reduced basal pinnae

15. *Sphaerostephanos*

- 19 Lower surfaces minutely hairy; 2-3 pairs reduced basal pinnae

13. *Pneumatopteris*

18 Sporangia not setose, in some cases bearing glands:

- 20 Yellow spherical glands present on lower surface of lamina and on sporangia

15. *Sphaerostephanos*

20 Yellow spherical glands lacking:

- 21 Basal pinnae rather abruptly reduced; lamina \pm pustular when dried; spores with many small wings 13. *Pneumatopteris*

- 21 Basal pinnae gradually reduced; lamina not pustular; wings on spores fewer and irregular

7. *Christella*1. *MACROTHELYPTERIS* (H. Ito) Ching.Acta Phytotax. Sinica **8**: 308 (1963)

Caudex suberect; scales narrow, \pm thickened at base, with marginal and superficial acicular and capitate hairs; fronds bipinnate-tripinnatifid with \pm adnate pinnules; scales on fronds, if present, with thickened bases, \pm setose margin and hair-tip; hairs on frond acicular and capitate, some long septate hairs always present; sori small, usually with a small indusium; sporangia usually with capitate hairs near annulus; spores with a \pm winged perispore. Chromosome number 31.

Nine species; tropics of the Old World from Mascarene Islands to Hawaii and Queensland.

1. *Macrothelypteris torresiana* (Gaud.) Ching, Acta Phytotax. Sinica **8**: 310 (1963); Holtt. Blumea **17**: 27 (1969) excl. syn. *Polypodium fragile* Bak.—*Polystichum torresianum* Gaud. in Freyc., Voy. Bot. : **333** (1824).—*Thelypteris torresiana* (Gaud.) Alston in Lilloa **30**: 111 (1960). Type: Mariana Isl., *Gaudichaud* (G !).

Aspidium uliginosum Kunze in Linnaea **20**: 6 (1847).—*Dryopteris uliginosa* (Kunze) C. Chr., Ind. Fil. Suppl. **3**: 100 (1934).—*Thelypteris uliginosa* (Kunze) Ching in Bull. Fan Mem. Inst. Biol. Bot. **6**: 342 (1936); Tard. in Humbert, Fl. Madag. 5e Fam. **1**: 284 (1958). Type: cult. Hort. Bot. Leipzig, origin Java (formerly LZ, now destroyed).

Polypodium tenericaule Hook. in J. Bot. Kew Misc. **9**: 353 (1857).—*Lastrea tenericaulis* Moore, Ind. Fil. : 99 (1858); Bedd., Handb. Ferns Brit. India: 266 (1883).—*Nephrodium tenericaule* Hook., Spec. Fil. **4**: 142, p.p. excl. t. 269 (1962). Type: China, *Alexander* (K !).

Nephrodium setigerum (Bl.) Hook & Bak., Syn. Fil.: 284, p.p. (1867).—*Dryopteris setigera* (Bl.) C. Chr., Ind. Fil.: 292, p.p. (1905).

Dryopteris lasiocarpa Hayata in J. Coll. Sci. Univ. Tokyo **30**: 417 (1911).—*Thelypteris oligophlebia* var. *lasiocarpa* (Hayata) H. Ito in Nakai & Honda, Nov. Fl. Jap. pt. **4**: 144 (1939). Type: Formosa, *Nakahara 994* (TI).

Dryopteris trichodes Rosenst. in Meded. Rijksherb. Leiden **31**: 6, p.p. (1917). Lecto: Java, *Zollinger 354* (L !).

Stipes glaucous, with dark brown scales at base; no scales on axes of frond, but long septate slender hairs always present on lower surface of axes; indusium small, bearing capitate hairs.

Madagascar, Reunion; also throughout range of genus. Now naturalized in various parts of the Americas.

2. *METATHELYPTERIS* (H. Ito) Ching

Acta Phytotax. Sinica **8**: 305 (1963).

Small ferns with short erect caudex; fronds pinnate with deeply lobed pinnae or bipinnate with adnate pinnules; basal pinnae not or little reduced; veins in pinna-lobes free, often forked, always ending short of the margin; costae prominent, not grooved, on upper surface; unicellular acicular hairs and/or short capitate hairs on lower surfaces, also short hair-like reduced scales consisting of several short cells with brown septa; sori indusiate; sporangia lacking hairs near annulus; chromosome number 35.

About 12 species; S. Tomé, Madagascar, India and Ceylon to S. China and Japan, Malesia, Solomon Islands.

1. *Metathelypteris fragilis* (Bak.) Holtt., comb. nov.—*Polypodium fragile* Bak. in Journ. Linn. Soc. Bot. **16**: 203 (1877). Type: Madagascar, *H. Gilpin* (K !).

Stipe probably 15–20 cm long; lamina 20 cm long, pinnae c. 8 pairs, opposite; basal pinnae a little shorter than next, narrowed near their bases; largest pinnae 6,5 × 2,0 cm, with a few free pinnules at their bases, connected by a very narrow wing along pinna-rachis; pinnules on basiscopic side of pinna longer than on acroscopic, largest 1,3 × 0,5 cm, lobed more than ½ way to midrib; veins pinnate in larger pinnule-lobes; acicular hairs on axes, both surfaces; one sorus on basal acroscopic branch of each vein; indusia with capitate hairs.

Only known from the type, and one specimen from S. Tomé (*Newton s.n.* 1885, K, ex Coimbra).

This species was wrongly included in a synonymy of *Macrothelypteris torresiana* (q.v. supra) by Holttum in *Blumea* **17**: 27 (1969).

3. *PSEUDOPHEGopteris* Ching

Acta Phytotax. Sinica 8: 313 (1963).

Caudex of African species erect or suberect; scales thin, crumpled and medium brown when dry, bearing short superficial hairs but not conspicuous marginal and apical hairs; fronds usually elongate with lower pinnae \pm reduced and more widely spaced; pinnae opposite or nearly so, bearing adnate pinnules which are \pm deeply lobed (in *P. diana*e no free pinnules); upper surface of costae not grooved; veins usually forked, not reaching margin; unicellular acicular and/or capitate hairs, also much-reduced filiform scales present on lower surface of frond-axes; sori exindusiate; sporangia setose only in *P. diana*e; spores with a slightly raised surface reticulum or sometimes lacking distinct surface features; chromosome number 31. Twenty species, distributed from St. Helena to Hawaii.

Fronds pinnate, without free pinnules 1. *P. diana*e

Fronds bipinnate:

Basal basiscopic pinnules conspicuously longer than next; lower surfaces throughout bearing abundant short blunt hairs 2. *P. henriquesii*

Basal basiscopic pinnules not conspicuously longer than next; acicular hairs only on lower surfaces:

Basal pinnules of larger pinnae smaller than middle ones 3. *P. aubertii*

Basal pinnules of larger pinnae not reduced 4. *P. cruciata*

1. *Pseudophegopteris diana*e (Hook.) Holtt. in Blumes 17: 21 (1969).—*Polypodium diana*e Hook., Spec. Fil. 4: 234 (1863); J. C. Mellis, St. Helena: 355, pl. 55 (1875).—*Dryopteris diana*e C. Chr., Ind. Fil.: 262 (1905). Type: St. Helena, *Cuming* 423 (K !).

Polypodium molle Roxb. in Beatson, St. Helena: 318 (1816), non Jacq.; Hook. & Bak., Syn. Fil.: 308 (1867).—*Phegopteris mollis* Kuhn, Fil. Afr.: 123 (1868), non Mett. Type: St. Helena, *Roxburgh s.n.* 1813–14 (BR ?).

Stipe 15–35 cm, densely and persistently scaly throughout (also lower surface of rachis), scales thin, to $6 \times 2\frac{1}{2}$ mm; lamina to more than 50 cm long and 30 cm wide; pinnae contiguous or overlapping, lowest pair slightly reduced with narrowed bases; largest pinnae commonly $16 \times 3\frac{1}{2}$ cm (to 22×7 cm), lobed to 1–3 mm from costa, basal basiscopic segments longest; segments of larger pinnae crenate; lower surfaces of costae and costules densely hairy; veins pinnate in lobes of pinna-segments; sori one or more to each vein-group, round or slightly elliptic; sporangia setose; spores thin-walled without evident markings.

Distribution: St. Helena; reported by Mellis in 1862 as a very common roadside fern along Sandy Bay Ridge; found also in 1956 (*N. R. Kerr*. K).

2. *Pseudophegopteris henriquesii* (Bak.) Holtt. in Blumea 17: 15 (1969).—*Polypodium henriquesii* Bak. in Bol. Soc. Brot. 4: 154, t.1 (1886).—*Dryopteris henriquesii* C. Chr., Ind. Fil.: 270 (1905); Exell, Cat. Vasc. Pl. S. Tomé: 64

(1944).—*Thelypteris henriquesii* Tard. in Notul. Syst. **14**: 344 (1952); Mem. Inst. Franc. Afr. Noire no **28**: 119, pl. xx, f. 10, 11 (1953).—*Macrothelypteris henriquesii* Pichi Sermolli in Webbia **23**: 179 (1968). Type: S. Tomé, 1 200 m. *A. Moller* 45 (K !).

Main rachis reddish at base, stramineous distally; lowest pinnae a little reduced; longest pinnae $20-35 \times 6-15$ cm, bearing broadly adnate pinnules connected by a narrow wing, basal basiscopic pinnules elongate; largest pinnules to 8×1.7 cm, lobed up to $\frac{3}{4}$ towards costule, veins pinnate in lobes; lower surfaces throughout bearing many short erect hairs with rounded little-swollen apices (similar hairs also between veins on upper surface) and also acicular hairs; sori medial on veins; sporangia not setose; spores not seen.

Distribution: S. Tomé.

3. *Pseudophegopteris aubertii* (Desv.) Holtt. in Blumea **17**: 18 (1969).—*Polypodium aubertii* Desv. in Mem. Soc. Linn. Paris **6**: 243 (1827).—*Macrothelypteris aubertii* Pic. Ser. in Webbia **23**: 177, fig. 2 (1968). Type: "Ins. Mascareigne" (on label: Bourbon), no collector cited (P).

Phegopteris helliana Fée, Gen. Fil.: 247 (1852). Type: Réunion, *de Hell* (isotype? P !).

Polypodium sharpeanum Bak. in Journ. Bot. **18**: 369 (1880).—*Dryopteris sharpeana* C. Chr., Ind. Fil.: 292 (1905). Type: Madagascar, *L. Kitching* (K !).

Main rachis stramineous or flushed with red; pinnae to at least 40×15 cm; basal pinnules smaller than middle ones; largest pinnules 8×2.5 cm, acuminate, lamina at base slightly adnate on acroscopic side, lobed almost to costa, segments slightly oblique, to 4 mm wide, lobed up to $\frac{1}{2}$ way to their midribs; lower surfaces of pinna-rachis, costae and costules bearing spreading pale hairs; sori 1 or 2 to each lobe of a pinnule-segment; sporangia not setose; spores with a slightly raised reticulum of large meshes.

Distribution: Réunion, Madagascar. Desvaux's description is detailed, and Pichi Sermolli has published a photograph of the type.

4. *Pseudophegopteris cruciata* (Willd.) Holtt. in Blumea **17**: 21 (1969). *Aspidium cruciatum* Willd. in L. Spec. Pl. ed. iv, **5**: 278 (1810).—*Dryopteris cruciata* C. Chr., Ind. Fil.: 259 (1905).—*Thelypteris cruciata* Tard. in Notul. Syst. **15**: 91 (1955); Alston, Ferns W. Trop. Afr.: 61 (1959); Tard. in Humbert, Fl. Madag. 5e Fam. **1**: 285, fig. xl, 7-9 (1958).—*Macrothelypteris cruciata* Pichi Sermolli in Webbia **23**: 179 (1968). Type: Mauritius, *Bory (Herb. Willd. no. 19821, B !)*.

Phegopteris straminea Fée, Gen. Fil.: 246 (1852). Type: Réunion, *de Montbrison* (orig. ?; dupl. FI !).

Polypodium bojeri Hook., Spec. Fil. **4**: 290 (1862). Type: Mauritius, *Bojer* (K !).

Nephrodium subglandulosum Bak., Syn. Fil.: 285 (1867). Type Réunion, Vieillard & Deplanche s.n. (K !).

Caudex erect; stipes to 30 cm or more long, stramineous or \pm rufous; lamina to 100 cm or more long, lowest 2–3 pairs pinnae gradually reduced; largest pinnae to 25 cm long, basal basiscopic pinnules not much longer than next; pinnules to 5×1.5 cm, distinctly narrowed at base but always adnate to pinna-rachis, larger ones deeply lobed, edges of lobes crenate; lower surface of frond-axes bearing slender hairs; veins simple or forked; sori on acroscopic vein-branches, not or little elongate; sporangia lacking hairs; spores not seen.

Distribution: Mascarene Islands; Tanzania, Kenya, Uganda, Congo, Ghana, Cameroons, Liberia.

It seems possible that West African specimens represent a distinct species. Plants of *P. cruciata* may be fertile from a rather early age, and comparison of small fronds from young plants with much larger fronds from mature plants is difficult, especially when different parts of a frond are represented in different collections. These plants need more field study, also cytological study. A plant from West Africa was found to be tetraploid (see Alston 1959).

4. *AMAUROPelta* Kunze

Farnkr. 1: 86, 109, t. 51 (1843).

Caudex erect, basal part often covered with a mass of tangled roots as in *Cyathea*; scales firm, rather broad, bearing a few superficial hairs; stipes short; fronds gradually attenuate to both base and apex; aerophores at bases of pinnae usually swollen; pinnae deeply lobed; veins simple (except in enlarged basiscopic pinna-lobes), basal ones passing to margin above base of sinus (except in *A. membranifera*); sessile hemispherical glands sometimes present on lower surface; capitate hairs of various sizes, sometimes orange or red, and acicular hairs, variously present on lower surface, the acicular hairs sometimes hooked; sori of African species with very small indusia bearing acicular and/or glandular hairs; sporangia short-stalked, lacking hairs or glands near annulus; spores opaque and indistinctly granular; chromosome number 29.

Type species: *A. breutelii* Kunze of West Indies, placed by Christensen as a synonym of *Aspidium limbatum* Sw.

The name *Amauropelta* means obscure indusium. American species have not all yet been distinguished as a group, though almost all are described in Christensen's Monograph of *Dryopteris* (1913) in subgenus *Lastrea*. When dealing with *A. bergiana* in Madagascar Christensen mentioned its similarity to one of the American species. African species are fewer than American, and have not yet been clearly characterized. The following account is tentative, and there are possibly other species which should be recognized. Most species in Africa seem to be variable in the character of their pubescence. *A. membranifera*

is aberrant in its connivent or sometimes united basal veins, and apparently also in its lower pinnae not much decrescent, but it agrees with *A. bergiana* in its hooked hairs, a character not known in any other African fern of this family.

C. C. Wood has published photographs of spores of American species as seen with a scanning electron microscope; they show a surface with a raised reticulum of a large number of very small meshes (Journ. Linn. Soc. Bot. **67**, Suppl.: 199, pl. 2 E, F, 3A, 1973). T. G. Walker has examined West Indian species cytologically, and was the first person to record the chromosome number 29 (Trans. R. Soc. Edinb. **66**, no. 9: 179, 214-217). He recorded this number for nine diploid species and one (unnamed) tetraploid. *A. bergiana* from Tristan da Cunha has been examined cytologically by Manton and Vida (Proc. R. Soc. B, **170**: 361-379, 1968) under the name *Thelypteris tomentosa*. They found $n = 84-87$, $2n = c. 170$, which they interpret as hexaploid on $n = 29$. In the herbaria at Kew and the British Museum all specimens from Tristan named *T. tomentosa* are *Amauropelta bergiana* according to the present treatment. No cytological observations of this genus in Africa have been published. Atkinson and Stokey have described gametophytes of West Indian species of this genus (Journ. Linn. Soc. Bot. **66**: 23-36, 1973).

In erect caudex and shape of sporangia this genus agrees with *Coryphopteris* of the Malayan region, but it differs in the gradually decrescent base of the frond and in spores; the large glands in the two genera also probably differ in their form and structure, a subject perhaps amenable to modern micro-chemical investigation. In frond-form and shape of sporangia *Amauropeltis* agrees with *Oreopteris*, but differs in spores, in venation and in glands. *Oreopteris limbosperma*, widely distributed in north temperate regions, occurs in Madeira but nowhere in Africa. Only two other species are certainly known but more may await recognition.

Lower pinnae with one or both basicopic segments enlarged both in length and width, and lobed:

Lowest veins connivent just below sinus or anastomosing with short excurrent vein; sinus-membrane broadly triangular 1. *A. membranifera*

Lowest veins passing to edge above base of sinus 2. *A. heteroptera*

Lower pinnae sometimes with \pm enlarged basal segments but these segments not much widened or lobed:

Glands and capitate hairs lacking on all parts of surface; indusia bearing acicular hairs only 3. *A. bergiana*

Hooked hairs present on lower surface between veins var. *bergiana*

Hooked hairs absent var. *calva*

Glands and/or capitate hairs present on lower surfaces and/or indusia:

Lower surface of rachis and costae bearing rather sparse stiff hairs 1 mm or more long; sori supramedial 4. *A. strigosa*

Lower surfaces of rachis and costae bearing rather copious shorter hairs; sori medial:

Large hemispherical glands abundant on lower surface between veins; basal

pinnae not widely spaced, lowest c. 1 cm long 5. *A. tomentosa*

Large hemispherical glands absent; basal pinnae widely spaced, lowest ≥ 3 mm long *A. oppositiformis*.6

1. *Amauropelta membranifera* (C. Chr.) Holtt. comb. nov.—*Dryopteris membranifera* C. Chr. in Bonap. Notes Pterid. 16: 170, pl. 2c (1925); Dansk. Bot. Ark. 7: 50 (1932).—*Cyclosorus membranifera* Ching, Bull. Fan Mem. Inst. Biol. Bot. 10: 246 (1941); Tard. in Humbert, Fl. Madag. 5e Fam. 1: 289, fig. xli, 13–15 (1958).—*Thelypteris membranifera* Reed in Phytologia 17: 292 (1968). Type: Madagascar, Perrier 6067 (P !).

Caudex and base of stipe unknown; lamina to 80 cm long, 1–2 pairs basal pinnae somewhat reduced. Largest pinnae 15–20 cm long, to 3 cm wide, basal acroscopic segment of lower pinnae much enlarged (to 3×1.5 cm) and deeply lobed with veins pinnate in the lobes; apex long-acuminate; edges lobed to 2 mm from costa, lobes subfalcate, slightly crenate, a broadly triangular translucent membrane at base of each sinus; costules 6 mm apart, veins 10–11 pairs, lowest pair connivent below sinus-membrane, or joining, with a very short excurrent vein; lower surface of rachis glabrous, costae densely short-hairy, hairs present also on costules, veins and surface, many of them hooked at tips; upper surface hairy on rachis and costa only. Sori small, inframedial, exindusiate.

Distribution: only known from two collections from Madagascar. The second collection (Humbert 12027) is quite glabrous beneath, but otherwise very close to the type. This species needs further study.

2. *Amauropelta heteroptera* (Desv.) Holtt., comb. nov.—*Nephrodium heteropterum* Desv. in Mem. Soc. Linn. Paris 6: 256 (1827).—*Aspidium heteropterum* Mett. ex Kuhn, Fil. Afr.: 134 (1868).—*Dryopteris heteroptera* C. Chr., Ind. Fil.: 270 (1905); Dansk Bot. Ark. 7: 45 (1932).—*Thelypteris heteroptera* Tard. in Humbert, Fl. Madag. 5e Fam. 1: 276, fig. xxxviii, 6–10 (1958). Type: Mascarene Islands, no collector cited (P !).

Polypodium sieberianum Kaulf. in Spreng., Syst. Veg. ed. 16, 4: 56 (1827). Type: Bourbon, Sieber (P !).

Phegopteris scalpturata Fée, Gen. Fil.: 245 (1852). Type: Bourbon, Pervillé (P !).

Aspidium stipulaceum Mett., Farngatt. IV: 82, no. 198 (1858). Type: Bourbon, Bory (not seen).

Stipe 5–8 cm long, short-hairy; lamina 30–90 cm long, gradually narrowed in basal part but lower pinnae not widely separated, lowest c. 1 cm long, triangular with truncate base dilated equally both sides. Largest pinnae commonly $8\text{--}12 \times 1.8\text{--}3.0$ cm (to $18 = 3$ cm); basal segments both \pm enlarged, usually about twice as wide as other segments and crenate to deeply lobed with veins pinnate in the lobes; edges lobed to $1\frac{1}{2}$ –2 mm from costa, lobes hardly falcate; costules $3\frac{1}{2}$ – $5\frac{1}{2}$ mm apart; veins 10–15 pairs, rather thick and prominent; lower surface of rachis and costae with dense spreading hairs to $\frac{1}{2}$ mm long, shorter and less dense on other parts, glands and capitate hairs lacking (one collection

is quite glabrous beneath); upper surface short-hairy throughout. Sori medial, sometimes distinctly elongate; indusium small, bearing acicular hairs of varying length and sometimes glands.

Distribution: all specimens seen are from Réunion (Bourbon).

Christensen (Ind. Fil.: 260) places *Polypodium sieberianum* Kaulf. as a synonym of *Polypodium cyatheifolium* Desv.; I did not find the type of the latter at Paris.

3. *Amauropelta bergiana* (Schlechtend.) Holtt., comb. nov.—*Polypodium bergianum* Schlechtend., Adumbr. Fil. Prom. B. Spei: 20, t. 9 (1825).—*Aspidium bergianum* Mett., Farngatt. IV: 79 (1858).—*Lastrea bergiana* Moore, Ind. Fil.: 86 (1858).—*Nephrodium bergianum* Bak., Syn. Fil.: 269 (1867).—*Dryopteris bergiana* Kuntze, Rev. Gen. Pl. 2: 812 (1891); Sim, Ferns S. Afr. ed. 2: 93, t. 10 excl. fig. b & c (1915); C. Chr., Dansk. Bot. Ark. 7: 44, pl. 9, fig. 6–12 (1932).—*Dryopteris prolixa* var. *bergiana* Alston apud Gilliland in J. S. Afr. Bot. 4: 149 (1938).—*Thelypteris bergiana* Ching in Bull. Fan Mem. Inst. Biol. Bot. 10: 251 (1941); Tard. in Humbert, Fl. Madag. 5e Fam. 1: 277, fig. xxxvii, 5–8 (1958); Schelpe, Fl. Zamb. Pterid.; 193, t. 55, fig. B (1970). Type: Kirstenbosch, *Bergius et al.* (not seen).

Nephrodium sewellii Bak. in Journ. Linn. Soc. Bot. 15: 418 (1876).—*Dryopteris sewellii* C. Chr., Ind. Fil.: 292 (1905). Type: Madagascar, *Pool s.n.* (K!).

Nephrodium anateinophlebium Bak. in Journ. Linn. Soc. Bot. 16: 202 (1877).—*Dryopteris anateinophlebia* C. Chr., Ind. Fil.: 252 (1905). Type: Madagascar, *H. Gilpin* (K!).

Aspidium maranguense Hieron. in Engl. Pflanzenw. Ost. Afr., C: 85 (1895).—*Dryopteris maranguensis* C. Chr., Ind. Fil.: 276 (1905).—*Lastrea maranguensis* Copel., Gen. Fil.: 139 (1947). Type: Kilamandjaro, *Volkens 1267* (B).

Dryopteris palmii C. Chr. in Ark. for Bot. 14, no. 19: 1, t. 2, f. 6 (1916). Type: Madagascar, *Afzelius & Palm* (C).

Caudex erect; stipes 5–17 cm long, short-hairy; lamina 30–90 cm long, lower pinnae gradually decrescent and more widely spaced, often narrowed at their bases. Largest pinnae 7.5–15 × 1.5–2.5 cm; base truncate, not dilated; apex acuminate; edges lobed to 1–2 mm from costa; lobes slightly oblique, hardly falcate; costules 3–4 mm apart; veins 8–10 pairs; lower surface of rachis, costae and costules bearing short spreading hairs some of which are hooked, slender erect hooked hairs on lower surface between veins; upper surface short-hairy throughout. Sori supramedial, small; indusia very small, bearing a few hairs.

Distribution: Madagascar, Réunion, S. Africa, Tanzania, Malawi, Zambia, Rhodesia, Kenya, Fernando Po.

Var. *calva* Holtt., var. nov., ab varietate typica differt: rachide, costis

costulisque subtus pilis brevibus rectis praedita, pilis hamatis destitutis; lamina inferiori inter venas calva. Type: Cameroon Mt, Mann's Spring, *P. W. Richards* 4308 (K). Also Cameroon Mt, 4 400 ft, *Maitland* 1134 (K). Specimens from Comoro Islands (*Humboldt* 270) and Réunion (*Herb. Richard* 284) similarly lack hooked hairs.

Var. *tristanensis* Holtt., var. nov., ab varietate typica differt: frondibus minoribus, subtus pilis longioribus numerosioribus praeditis; pinnis inferioribus basi dilatatis. Type: Tristan da Cunha, *Carmichael* (K). As noted above, similar plants from Tristan have been found to be hexaploid.

4. ***Amauropelta strigosa*** (Willd.) Holtt., comb. nov.—*Aspidium strigosum* Willd., in Linn. Sp. Pl. ed. IV, 5: 249 (1810).—*Dryopteris strigosa*, C. Chr., Ind. Fil.: 295 (1905); Dansk Bot. Ark. 7: 45 (1932).—*Thelypteris strigosa* Tard. in Humbert, Fl. Madag. 5e Fam. 1: 274, fig. xxxviii, 11–15 (1958). Type: Mauritius, *D. Flüge* (*Herb. Willd.* 19,778, B !).

Lamina commonly to 50 cm (to 90 cm) long, lower 7–10 pairs pinnae gradually reduced. Largest pinnae commonly 12–15 × 1.5–2.5 cm (width above base); base truncate with both basal segments ± elongate but entire; apex evenly attenuate; edges lobed to 1 mm from costa; costules 3 mm apart; veins 8–10 pairs; lower surface of rachis and costae bearing scattered stiff pale spreading hairs 1 mm or more long; broad resinous glands on surfaces sparse, smaller spherical ones occasional on costules and veins; upper surface short-hairy on edges of costal groove, with a few short hairs distally on costules and veins. Sori supramedial; indusia very small with a few glands and/or short hairs.

Distribution: Mauritius, Réunion; Madagascar?

There are specimens from Mauritius and Réunion which are intermediate between typical *A. strigosa* and *A. tomentosa*. These specimens have varying numbers of shorter hairs on the lower surface of rachis and costae (in some cases minute spreading hairs only, in some many hairs $\frac{1}{4}$ – $\frac{1}{2}$ mm long), and large glands varying from many as in *A. tomentosa* to none. Sori in some cases are almost medial.

As noted by Christensen (*l. c.* 1932) it is doubtful whether this species exists in Madagascar; I have not seen the specimens cited by Tardieu.

5. ***Amauropelta tomentosa*** (Thouars) Holtt., comb. nov.—*Polypodium tomentosum* Thouars, Fl. Tristan d'Ac.: 32, t. 3 (1804).—*Nephrodium tomentosum* Desv., Mem. Soc. Linn. Paris 6: 256 (1827).—*Dryopteris tomentosa* Kuntze, Rev. Gen. Pl. 2: 813 (1891); C. Chr., Dansk. Bot. Ark. 7: 45 (1932).—*Thelypteris tomentosa* Ching, Bull. Fan Mem. Inst. Biol. Bot. 10: 255 (1941). Type: Tristan da Cunha, *Thouars* (P !).

Aspidium riparium Bory ex Willd. in Linn. Sp. Pl. ed. IV, 5: 250 (1810). Type: Réunion, *Bory* 82 (*Herb. Willd.* no. 19,782, B !).

Stipes to 7 cm long; lamina 30–45 cm; 5–6 pairs lower pinnae gradually reduced, \pm triangular with truncate base enlarged on acroscopic side, lowest 1 cm long. Largest pinnae to 12 cm long, to 2.5 cm wide above base; basal segments \pm elongate, basiscopic sometimes more than acroscopic; apex gradually attenuate; edges lobed to 1–1½ mm from costa; costules to 4 mm apart; veins 8–10 pairs; lower surface of rachis densely covered with erect hairs ½ mm long, similar but shorter hairs on costae, few hairs on costules; whole lower surface bearing many large red hemispherical glands; upper surface \pm densely short-hairy throughout. Sori medial; indusia very small, bearing red glands.

Distribution: apart from the type, only known from Réunion and Mauritius. It seems possible that the type was wrongly localized; all other specimens from Tristan da Cunha named *Thelypteris tomentosa* in the herbaria at Kew and BM are *A. bergiana*. The figure published by Tardieu in Humbert, Fl. Madag. 5e Fam. 1; fig. xxxviii, 1–5, is more densely hairy than any specimen of the species seen by me, and rather large hairy indusia are indicated; Christensen (l. c. 1932) stated that he had seen no specimens from Madagascar.

6. ***Amauropelta oppositiformis*** (C. Chr.) Holtt., comb. nov.—*Dryopteris oppositiformis* C. Chr. in Bonap. Notes Pterid. 16: 173, t. 2 (1925).—*Thelypteris oppositiformis* Ching, Bull. Fan Mem. Inst. Biol. Bot. 10: 253 (1941); Tard. in Humbert, Fl. Madag. 5e Fam. 1: 272, fig. xxxvii, 1–4 (1948). Type: Madagascar, Perrier 7582 (P !)

Dryopteris tsaratananensis C. Chr., Dansk. Bot. Ark. 7: 45, pl. 9, fig. 1–5 (1932). *Thelypteris tsaratananensis* Ching, Bull. Fan Mem. Inst. Biol. Bot. 10: 255 (1941); Tard. in Humbert, Fl. Madag. 5e Fam. 1: 278 (1958). Type: Madagascar, Mt Tsaratanana, Perrier 16455 (P !).

Thelypteris strigosa sensu Schelpe, Fl. Zamb. Pterid.: 193 (1970).

Stipes 2–7 cm long; lamina to 60 cm long, lower pinnae gradually smaller and more widely spaced, lowest 2–3 mm long. Largest pinnae 6–9 \times 1.0–1.5 cm; base truncate, not enlarged either side; apex acuminate; edges lobed to 1–1½ mm from costa; lobes slightly oblique, hardly falcate, tips rounded to broadly pointed; costules 2–3 mm apart; veins to 7 pairs; short-stalked or sessile reddish glands of varying size present on costules and veins of lower surface, rachis and costae with short erect hairs; upper surface of costae and costules hairy, hairs between veins few or none. Sori medial or a little inframedial; indusia small, bearing a few short acicular and glandular hairs.

Distribution: Madagascar, Uganda, Kenya, Tanzania, Ethiopia, Sudan, Nigeria, Cameroons, Rhodesia.

The specimens here included vary considerably in the abundance and nature of their glandular hairs; most of them were formerly named *T. bergiana*.

Christensen distinguished *A. oppositifomis* from other Madagascan species by its narrow fronds (the type has a frond 5 cm wide), but other specimens with wider fronds agree with the type in essential characters. He distinguished *D. tsaratananensis* by lack of glands on the lower surface, but the type has distinct stalked orange glands quite similar to the smaller glands on the type of *A. oppositifomis*.

Some of the specimens referred here from Kenya, Uganda and elsewhere in Africa have \pm enlarged basal pinna-lobes, in extreme cases toothed. It may be that these should be separated, but I do not see a clear division, and there is much variation among them.

5. *PARATHELYPTERIS* (H. Ito) Ching

Acta Phytotax. Sinica **8**: 300 (1963) p.p.; Holtt., Blumea **19**: 32 (1971).

Ching originally included in this genus a number of species which do not appear to me to be at all closely related to the designated type *Aspidium glanduligerum* Kunze (N.E. India to Japan). After removal of these alien species, the generic characters are: caudex a long-creeping slender rhizome; fronds rather small, with deeply pinnatifid pinnae and free veins; glands and slender septate hairs often present on lower surfaces; spores opaque with indistinct surface features and a slight irregular wing. The type species has basal pinnae not reduced, but two others have fronds long-decrescent at the base with very small basal pinnae; one of the latter is *Parathelypteris beddomei* (Bak.) Ching which occurs in South India and Ceylon (also on mountains in Malesia). A new species recently found in the island of Réunion agrees in habit with *P. beddomei* but has pinnae with wider lobes, no glands, and copious short hairs; in shape of pinnae and their indumentum the Réunion plant more nearly resembles a species from Brazil, *Thelypteris rivularioides* (Fée) Abbiatti. It is not clear to me whether this Brazilian species and its allies (which have not been recognized as a group) could be placed in *Parathelypteris*; if they were so placed, the genus would need re-defining. In the present uncertainty, the best course seems to be to describe the Réunion plant as a species of *Parathelypteris*, pointing out that a fuller understanding of it will probably involve the study of South American species. *Parathelypteris* agrees with *Amauropelta* in spores, so far as one can judge with the light microscope, but *Amauropelta* differs in having a rather massive erect caudex. *Amauropelta* species have a chromosome number 29; the number for *Parathelypteris beddomei* is 31.

1. *Parathelypteris salazica* Holtt., sp. nov.

Rhizoma longe repens, 2–2½ mm diametro, in sicco nigrum, stipites inter se 1–2 cm distantes ferens. Stipites 6 cm longi, basi nigri glabrique, sursum pallidi pilis patentibus 1½ mm longis vestiti; rachis similiter vestita. Lamina 40 cm vel ultra longa; pinnae usque 25-jugatae, inferiores 10-jugatae sensim reductae et

remotiores, infimae c. 5 mm longae et latae. Pinnae maximae 4 cm longae, medio 1,0 cm latae, basi dilatata usque 1,5 cm latae, apice breviter acutae, $\frac{2}{3}$ costam versus lobatae, lobis obliquis; costulae 4 mm inter se distantes; venae in lobis basalibus usque 6-jugatae, interdum furcatae, in lobis medialibus 4–5-jugatae simplices, venis infimis ad marginem supra basin sinus procurrentibus; rachis costaeque subtus pilis brunnescentibus $1\frac{1}{2}$ mm longis conspersis pilisque brevibus multis vestitae; pagina inferior inter venas pilis erectis minutis praedita; costae supra breviter hirsutae, lamina omnino pilis minutis vestita. Sori submarginales; indusia pilis brevibus praedita.

Type: RÉUNION, Plaine des Salazes, 2 200 m; fissures humides (avec Spahnum e Hépatiques), *Cadet 1981* bis (P).

6. *PSEUDOCYCLOSORUS* Ching

Acta Phytotax. Sinica 8: 322 (1963).

Caudex erect or short-creeping; scales broad, thin, lacking superficial hairs. Fronds bipinnatifid with abrupt transition at the base to numerous small pinnae; aerophores, more or less swollen, present at the bases of at least the lower large and reduced pinnae; veins free, basal acroscopic vein of a group passing to base of a sinus between two pinna-lobes, basisopic vein to edge above base of sinus; indumentum of acicular and short capitate hairs, variously distributed; sori indusiate; sporangia lacking hairs or glands near annulus, usually with a hair of 3 cells on their stalks, apical cell somewhat swollen; spores bearing numerous small isodiametric wings. Chromosome number: 35 and 36 both reported; further observations needed.

About 12 species, one widely distributed in Africa, two here described as new; the other species are on mainland tropical and subtropical Asia and Japan, one of them also in Luzon (northern island of the Philippines).

Reduced pinnae each consisting of a prominent aerophore, with no distinct lamina
1. *P. camerounensis*.

Reduced pinnae distinctly leafy:

Basal acroscopic segment of lowest large pinna enlarged and deeply lobed; capitate hairs lacking on lower surfaces 2. *P. johannae*.

Basal acroscopic segment of lower large pinnae not enlarged nor lobed; capitate hairs abundant all over lower surfaces, sometimes short acicular hairs also 3. *P. pulcher*.

1. *Pseudocyclosorus camerounensis* Holtt., sp. nov.

Caudex arborescens (collector); stipes fere ad basin pinnis multo reductis plurijugatis c. 3 cm inter se distantibus praeditus. Lamina 80 cm longa, pinnis 30-jugatis constituta; pinnae evolutae inferiores et pinnae reductae aerophoris tumidis praeditae. Pinnae maximae 20 × 2,4 cm, basi truncata acroscopice leviter auriculatae, basisopice rotundatae, apice anguste acuminatae, usque alam $1\frac{1}{2}$ mm latam lobatae; lobi falcati, acuti, pilis pallidis ciliati; costulae 4 mm inter se distantes; venae usque 15-jugatae, supra pallidae et prominentes; rachis

subtus pilis sparsis pallidis praedita, costae pilis rigidis patentibus $\frac{1}{2}$ mm longis vestitae, costulae minute pilosae, pagina inferior cetera glabra; costae costulaeque supra hirsutae, pagina superior cetera glabra. Sori mediales; indusia firma, glabra.

Type: CAMEROUN, Djuttitsa, 2 000 m, Meurillon CNAC 726 (P; K !).

This species is closely allied to *Pseudocyclosorus tylodes* (Kunze) Ching of India and China, differing in the medial sori and conspicuously hairy lower surfaces of costae. It should be noted that the specific epithet *tylodes* was wrongly printed *xyloides* in the original description (published after Kunze's death); it is clear from other references in the text that *tylodes* was intended, and this spelling was accepted by Mettenius and Hooker.

2. ***Pseudocyclosorus johannae* Holtt., sp. nov.**

P. pulchro (Willd.) Holtt. affinis, differt: pinnis inferioribus basi acroscopice valde auriculatis, auriculis 2,5 cm vel ultra longis profunde lobatis, lobis 1 mm latis; pagina inferiori rhachi, costarum costularumque pilis acicularibus solum vestita, pagina laminae inter venas glabra; indusia pilis brevibus acicularibus praedita.

Type: JOHANNA ISLAND, C. W. Bewsher 24, March 1877 (K!).

The type is somewhat smaller than the full development of *P. pulcher*; its largest pinna measures $20 \times 2,2$ cm. No other specimens are known to me.

3. ***Pseudocyclosorus pulcher* (Bory ex Willd.) Holtt., comb. nov.**—*Aspidium pulchrum* Bory ex Willd. in Linn. Sp. Pl. ed IV, 5: 253 (1818).—*Nephrodium pulchrum* Desv., Mem. Soc. Linn. Paris 6: 256 (1827).—*Lastrea pulchra* Presl, Tent. Pterid.: 75 (1836). Type: Réunion, Bory 81 (*Herb. Willd. no. 19, 787, B !*).

Nephrodium longicuspae Bak. in Journ. Linn. Soc. Bot. 16: 202 (1877).—*Aspidium longicuspae* Kuhn in v. Deck. Reisen 3 (3) Bot.: 65 (1879).—*Dryopteris longicuspis* C. Chr., Ind. Fil.: 275 (1905); Dansk. Bot. Ark. 7: 46, pl. 9 fig. 13–18 (1932).—*Thelypteris longicuspis* Schelpe, Journ. S. Afr. Bot. 31: 262 (1965); Fl. Zamb. Pterid.: 192 (1970).—*Lastrea longicuspis* Pic. Ser. in Webbia 23: 175 (1968). Type: Madagascar, H. Gilpin (K!).

Nephrodium zambsiacum Bak. in Ann. Bot. 5: 318 (1891).—*Aspidium zambsiacum* Hieron. in Engl. Pflanzenw. Ost. Afr. C: 85 (1895).—*Dryopteris zambsiaca* C. Chr., Ind. Fil.: 318 (1905).—*Thelypteris zambsiaca* Tard. in Notul. Syst. 14: 345 (1952); Tard. in Humbert, Fl. Madag. 5e Fam. 1: 278, fig. xxxix, 4–7 (1958). Type: Malawi, Shire Highlands, Buchanan (K!).

Dryopteris aequibasis C. Chr. in Bonap. Notes Pterid. 16: 162 (1925).—*Thelypteris zambsiaca* var. *aequibasis* Tard. in Humbert, Fl. Madag. 5e Fam. 1: 280 (1958). Type: Madagascar, Tananarive, Perrier 7580 (BM!).

Caudex erect; base of stipe to first large pinna 70 cm; reduced pinnae 3–5

cm apart, up to 10 pairs or more, lowest 3–5 mm long, uppermost 1.5 cm, deeply lobed; 1–2 pairs pinnae of intermediate size sometimes present; lowest large pinna gradually narrowed in basal 4–6 cm to a base 2 cm wide; aerophores swollen. Largest pinnae 20–28 cm long, 2.0–3.5 cm wide, base truncate but not or little auricled, apex caudate-acuminate (cauda 2.5 cm long), lobed to 1–1½ mm from costa, lobes hardly falcate, conspicuously fringed; costules to 4½ mm apart; veins to 18 pairs; lower surface of rachis and costae sparsely hairy, lower surface of costules, veins and lamina more or less copiously provided with short capitate hairs, sometimes with some acicular hairs; upper surface with or without short acicular and capitate hairs between veins. Sori medial; indusia firm, on the type covered with short capitate hairs only, acicular hairs present on some other specimens, capitate hairs in some cases few.

Distribution: Mauritius, Réunion, Madagascar, Malawi, Tanzania, Rhodesia, Uganda, Kenya, Ethiopia, Congo, Cameroons, Fernando Po.

Specimens from some parts of Africa have almost smooth indusia (capitate hairs very few); there is variability also in the abundance of capitate hairs on lower surface between veins. All Madagascan specimens at Kew, including the type of *Nephrodium longicuspe*, have rather small fronds (pinnae 15–20 cm long) and less abundant capitate hairs than the type of *C. pulcher*.

Dryopteris aequibasis C. Chr. was based on small specimens, probably from a young plant which have only one pair of reduced pinnae. Lower surfaces of rachis and costae are more copiously hairy than in larger specimens of *C. pulcher*; this might have been due to an exposed position. Sporangia are young, so spores cannot be seen.

7. *CHRISTELLA* Lévillé

Flore de Kouy-tchéou: 472 (1915); Holttum in *Blumea* **19**: 43 (1971).

In the paper of 1971 above cited, p. 45, I noted that certain free-veined species of tropical America appeared to belong to this genus, but I did not attempt to define their status. In the same year Dr Alan R. Smith published a detailed survey of these species (Univ. Calif. Publ. Bot. **59**: 1–136). Since 1971 I have come to realize that a group of African species are closely related to the American ones. These species differ from the type species of *Christella* (*C. parasitica*) in lacking elongate glandular hairs on the stalks of their sporangia, and in venation. They agree in the base chromosome number 36. I here propose for them the status of a new section of the genus *Christella*. The most important characters of the genus as a whole are: fronds bipinnatifid, always ± decrescent at base, rarely with an abrupt transition to much-reduced basal pinnae; indumentum of acicular and short capitate hairs, never sessile spherical glands; sporangia never with hairs or glands near the annulus; spores with rather slightly raised ridges or wings of irregular shape. The sections are thus distinguished:

Hair on sporangium stalk consisting of a single elongate glandular cell (similar glandular hairs present also on lamina in some species); veins always anastomosing (except in two species of the western Pacific); distribution mainly in the Old World Sect. *Christella*
 Elongate glandular hairs lacking from sporangium-stalks (acicular hairs sometimes present); veins all free, basal veins of adjacent groups connivent below the base of a sinus between two pinna-lobes, in some species sometimes united Sect. *Pelazoneuron*

SECT. CHRISTELLA

Pinnae crenate or shallowly lobed 1. *C. distans*
 Pinnae lobed at least half way to costa:

Pinnae commonly at least 10 cm long; indusia hairy:

Basal pinnae deflexed but not reduced nor more widely spaced; large elongate orange glands on veins of lower surface 2. *C. parasitica*

Basal pinnae, usually 2-4 pairs, gradually reduced; glandular hairs, if any, small, capitate:

Fronds to 200 cm tall, largest pinnae 23-30 cm long 3. *C. altissima*

Fronds and pinnae much smaller:

Caudex erect; pinnae lobed $\frac{3}{4}$ towards costa; basal veins anastomosing with a short excurrent vein to sinus, next veins to edge; some capitate hairs present 4. *C. hilsenbergii*

Caudex short-creeping; pinnae lobed less deeply; one or both second veins passing to sides of sinus-membrane; no capitate hairs 5. *C. dentata*

Pinnae to c. 3.5 cm long; indusia glabrous 6. *C. modesta*.

1. *Christella distans* (Hook.) Holtt., comb. nov.—*Nephrodium distans* Hook., Spec. Fil. 4: 76 (1862).—*Aspidium distans* Kuhn, Fil. Afr.: 209 (1868), non Viviani 1825.—*Dryopteris distans* Kuntze, Rev. Gen. Pl. 2: 812 (1891); C. Chr. in Dansk. Bot. Ark. 7: 51 (1932).—*Cyclosorus distans* Ching in Bull. Fan Mem. Inst. Biol. Bot. 10: 244 (1941); Tard. in Humbert, Fl. Madag. 5e Fam. 1: 297 (1958).—*Thelypteris distans* Reed in Phytologia 17: 276 (1968). Type: Madagascar, Boivin (K !).

Nephrodium eurostotrichum Bak. in Journ. Bot. 18: 329 (1880).—*Dryopteris eurostotrichum* C. Chr., Ind. Fil.: 263 (1905). Type: Madagascar, L. Kitching (K !).

Caudex long-creeping; stipe to 30 cm; lamina to 60 cm long with 15 pairs pinnae, apex almost pinna-like, 1-3 pairs lower pinnae gradually smaller, lowest narrowed towards base on basiscopic side, \pm auricled on acroscopic. Largest pinnae 12×2.2 cm, widest at truncate base, tapering rather evenly, edges crenate to depth of 2-3 mm; costules $3\frac{1}{2}$ mm apart; veins to 9 pairs, 2-2 $\frac{1}{2}$ pairs anastomosing, 2 pairs to sides of membrane; lower surface of costae rather long-hairy, shorter hairs on costules, veins and lamina; upper surface with scattered stiff hairs on costules like those on costae, few other hairs. Sori inframedial; indusium large, with short hairs.

Distribution: Madagascar and Comoro Islands.

2. *Christella parasitica* (L.) Lév., Fl. Kouy-tcheou: 475 (1915).—*Polypodium parasiticum* L., Sp. Pl.: 1090 (1753); C. Chr. in Ark. for Bot. 9, no. 11: 26, f. 4 (1910).—*Aspidium parasiticum* Sw. in Schrad. Journ. Bot. 1800 (2): 35 (1801).—

Nephrodium parasiticum Desv. in Mem. Soc. Linn. Paris **6**: 260 (1827).—*Dryopteris parasitica* Kuntze, Rev. Gen. Pl. **2**: 811 (1891); C. Chr., Ind. Fil.: 282, p.p. (1905).—*Cyclosorus parasiticus* Farw. in Amer. Midl. Nat. **12**: 259 (1931); Holtt., Rev. Fl. Malaya **2**: 281, fig. 162 (1955).—*Thelypteris parasitica* Fosberg, Occ. Pap. Bishop Mus. **23**: 30 (1962). Type: Canton, Osbeck (in Herb. Sw., S-PA).

Nephrodium didymosorum Parish ex Bedd., Ferns Br. India: t. 200 (1866).—*Dryopteris didymosora* C. Chr., Ind. Fil.: 262 (1905). Type: Moulmein, Parish (not seen).

Nephrodium tectum Wall. ex Bedd., Handb. Ferns Br. India Suppl.: 79 (1892). Type: India, Wallich 394 (K !).

Thelypteris fadenii Fosberg & Sachet in Smiths. Contr., Bot. **8**: 9 (1972). Type: Uganda, Kampala, K. A. Lyne 5186 (MHU; US, K !, P !).

Caudex short-creeping; stipes to c. 40 cm long, bearing slender spreading hairs; lamina to 40–50 cm long, texture thin; lower pinnae deflexed but not reduced nor more widely spaced, auricled at acroscopic base. Largest pinnae 12×2 cm, short-acuminate, lobed $\frac{2}{3}$ – $\frac{3}{4}$ towards costa, lobes slightly oblique; costules 4 mm apart; veins 8–10 pairs, lowest anastomosing with short excurrent vein to sinus, next to edge; lower surfaces generally covered with slender spreading hairs to 1 mm long, thick orange glandular hairs scattered on costules and veins in lobes; upper surface of costae antrorse-hairy, scattered long hairs on veins, very short hairs between veins. Distal sori medial, lower ones divergent, lowest sometimes touching; indusia hairy.

Distribution: widely in tropical Asia and the Pacific; in Africa apparently only known from Uganda.

This species has been much confused with *C. dentata*. There appears to be variation in the length of the creeping caudex, also in the abundance of the glandular hairs on the lower surface; these hairs are more abundant on the type of *Thelypteris fadenii* than is usual in this species in Asia. Manton and Sledge report that *C. parasitica* in Ceylon is tetraploid (Phil. Trans. R. Soc. B, **238**: 138, 1954). Possibly the plant described as *T. fadenii* in Uganda is a tetraploid of origin different from the Ceylon plant.

3. *Christella altissima* Holtt., sp. nov.

Caudex longe repens, 1 cm diametro; stipes 40 cm longus, breviter pilosus paleis $10 \times 1\frac{1}{2}$ mm onustus; lamina usque 200 cm longa, pinnis inferioribus 6-jugatis vel pluribus sensim reductis, majoribus valde auriculatis, auricula acuminata, profunde lobata; pinnae maximae 28–34 cm longae, 2.5–3.5 cm latae, basi subtruncatae, anguste acuminatae, $\frac{2}{3}$ – $\frac{3}{4}$ costam versus lobatae, lobis falcatis obtusis; costulae $4\frac{1}{2}$ – $5\frac{1}{2}$ mm inter se distantes; venae 11–15-jugatae, $1\frac{1}{2}$ -jugatis anastomosantibus, 1-jugatis membranam sinus tegentibus; pagina

inferior omnino pilis patentibus $\frac{1}{3}$ – $\frac{1}{2}$ mm longis vestita; costa supra pilis $\frac{3}{4}$ mm longis vestita, costulae venaeque pilis aequilongis conspersis praeditae, lamina inter venas pilis suberectis $\frac{1}{3}$ mm longis praedita. Sori mediales, inferiores supramediales, infimi non coalescentes; stipituli sporangiorum pilis unicellularibus elongatis vel glanduliformibus vel acicularibus praediti; sporae (semper?) abortivae.

Type: NATAL, in a bog, *Buchanan 103b* (K !); also at K, similar *Buchanan 8, 186*.

This differs from the Natal plants of *C. dentata* in its much larger size, more veins anastomosing, and in the presence of long acicular hairs on the stalks of many sporangia. *Buchanan 8* is one of the specimens cited by Schelpe under *Thelypteris dentata* var. *buchanani* (Journ. S. Afr. Bot. **31**: 265, fig. 1d; 1965) but the type of that variety has pinnae much less deeply lobed, and I judge it to be a possible hybrid between *Pneumatopteris afra* and *Christella dentata*.

4. *Christella hilsenbergii* (Presl) Holtt., comb. nov.—*Nephrodium hilsenbergii* Presl, Epim. Bot.: 47 (1851). Type: Mauritius, *Sieber 49* (PRC, P ! K !).

Nephrodium quadrangulare Fée, Gen. Fil.: 308 (1852).—*Dryopteris quadrangularis* Alston in Journ. Bot. **75**: 253 (1937).—*Cyclosorus quadrangularis* Tard. in Notul. Syst. **14**: 345 (1952).—*Thelypteris quadrangularis* Schelpe in Journ. S. Afr. Bot. **30**: 196, t. 1 fig. b (1964); Fl. Zamb. Pterid.: 195 (1970); A. R. Smith in Univ. Cal. Publ. Bot. **59**: 64, fig. 114 (1971). Type: Guyana, *Leprieur 182* (P?, NY).

Dryopteris contigua Rosenst. in Meded. Rijksherb. Leiden no. **31**: 8 (1917).—*Cyclosorus contiguus* Copel., Gen. Fil.: 142 (1947).—*Thelypteris contigua* Reed in Phytologia **17**: 269 (1968). Type: Borneo, *Teuscher* (L !).

Caudex erect; stipes c. 30 cm long; lamina 30–40 cm long, softly herbaceous, pinnae usually rather close, middle ones at right angles to rachis, lower 2–4 pairs \pm reduced and deflexed but not much more widely spaced, several pairs lower pinnae with enlarged and \pm crenate basal acroscopic segment. Largest pinnae commonly 8–12 \times 1.2–1.5 cm (to 14 \times 1.9 cm), acuminate, lobed at least $\frac{3}{4}$ towards costa (to 1–2 mm from costa), lobes slightly oblique, slightly falcate, ends rounded; costules 3–3 $\frac{1}{2}$ mm apart; veins 7–8 pairs; all lower surfaces covered with slender spreading hairs to 1 mm long, some capitate hairs, sometimes orange, on costules; slender \pm appressed hairs on and between veins of upper surface throughout, sometimes also capitate hairs, in addition to longer ones on costae and costules. Sori usually a little inframedial; indusium bearing hairs $\frac{1}{2}$ mm long in middle.

Distribution: Mauritius, Réunion, Madagascar, Seychelles; Mozambique, Malawi, Rhodesia, Kenya, Tanzania, Sudan, Nigeria, Ghana, Ivory Coast, Fernando Po; also widely in tropical Asia and tropical America.

Plants of this species have been recorded as diploid in Nigeria, Ghana, Ceylon and Florida. For references to distribution in the Americas, see A. R. Smith l.c. 1971. There are local varieties of this species, those in America characterized and named by A. R. Smith. Specimens from the Seychelles differ from the Mauritius type in lower surface and indusia less hairy and rather supramedial sori. Those in Ceylon and Malesia have shorter middle pinnae and more decrescent basal ones, with local differences in pubescence.

5. *Christella dentata* (Forsk.) Holtt., comb. nov.—*Polypodium dentatum* Forsk., Fl. Aegypt. Arab.: 185 (1775).—*Dryopteris dentata* C. Chr. in K. Dansk. Vid. Selsk. Skr. Afd. VIII, 6: 24 (1920).—*Thelypteris dentata* E. St John in Amer. Fern Journ. 26: 44 (1936); Schelpe, Fl. Zamb. Pterid.: 97 (1970); A. R. Smith in Univ. Cal. Publ. Bot. 59: 57 (1971).—*Cyclosorus dentatus* Ching in Bull. Fan Mem. Inst. Biol. Bot. 8: 206 (1938); Tard. in Humbert, Fl. Madag. 5e Fam. 1: 290 (1958). Type: Yemen, *Forskal* (C).

Aspidium aquapimense Schum. in K. Dansk. Vid. Selsk. Skr. Afr. 4: 230 (1829). Type: Guinea, *Thonning* (C).

Aspidium violascens Link, Hort. Berol. 2: 115 (1833); Mett., Fl. Hort. Lips: 91 (1856)—*Nephrodium violascens* Fée, Gen. Fil.: 305 (1852). Type: cult. Hort. Berol. (B !).

Nephrodium hispidulum A. Peter in Fedde Repert. Beih. 40, 1: 58, Descr. 10, t.4 a,b (1920). Type: Rhodesia, *A. Peter* (B).

Cyclosorus subpubescens sensu Holtt., Rev. Fl. Malaya 2: 273, 624, fig. 157 (1955), non Bl.

Caudex short-creeping, size of fronds very variable according to situation; stipes to 50 cm; frond to 90 cm long, lower 2–4 pairs pinnae gradually smaller, more widely spaced, with enlarged crenate basal acroscopic lobes. Largest pinnae to 15×2.5 cm, lobed a little over $\frac{1}{2}$ way to costa; costules $3\frac{1}{2}$ –4 mm apart; veins 8–9 pairs, lowest pair anastomosing with excurrent vein to sinus, one or both of next pair to sides of membrane; lower surface of rachis and costae bearing erect hairs $\frac{1}{2}$ mm long, shorter hairs on costules, veins and surface; upper surface with long hairs on costa and scattered on costules and veins, minute hairs between veins. Sori medial; indusia short-hairy.

Distribution: throughout tropics of Old World, adventive in some parts of tropical America.

This species has been shown to be tetraploid in Ceylon, and is everywhere variable. It grows in somewhat open places and has followed the destruction of forest by man. Local cytotaxonomic studies will probably reveal the existence of hybrids (see Ghatak, Manton & Holttum, British Fern Gazette 10: 183–192, 1971).

Dryopteris parasitica var. *coriacea* Bonap., Notes Pterid. 5: 81 (1917) was

based on a Madagascan specimen described simply as unusually coriaceous (*Viguiér & Humbert 664, P !*). Apart from their coriaceous texture the fronds, in my judgement, are not distinguishable from *Christella dentata*. Christensen wrote on the herbarium sheet "perhaps *D. mauritiana* forma", but sporangia are unlike those of *D. mauritiana* (*Spaerostephanos elatus* of the present paper).

6. *Christella modesta* Holtt. sp. nov.

Caudex brevis, erectus (?); stipes usque 7 cm longus, stramineus; lamina usque 16 cm longa, anguste acuminata, pinnis c. 10-jugatis constituta, pinnis infimis reductis; pinnae infimae 10–14 mm longae, basi basiscopice angustatae acroscopice non auriculatae; pinnae maximae $3,3 \times 0,7$ cm, breviter acuminatae, dimidio costam versus lobatae, lobis obliquis ciliatis vix falcatis; costulae $2\frac{1}{2}$ mm inter se distantes; venae 3–4-jugatae, infimae sub angulo acuto anastomosantes vel interdum ad basin sinus conniventes; rachis, costae, costulaeque subtus pilis rigidis $\frac{1}{2}$ – $\frac{3}{4}$ mm longis sparsim vestitae, pagina inferior cetera glabra; costae costulae venaeque supra pilis rigidis sparsis praeditae. Sori mediales, indusia glabra.

Type: MADAGASCAR, Zahamena (Réserve naturelle no. 3), *R. Decary 16,485 (P!)*.

The spores of this plant agree with *Christella*, but the sporangia appear to lack glandular hairs on their stalks. No other species of sect. *Christella* has glabrous indusia.

SECT. PELAZONEURON, Holtt., Sect. nov.

Venae infimae acroscopicae ad basin sinuum procurentes, basiscopicae vel cum acroscopicis conniventes vel ad marginem prope bases sinuum procurentes; raro venae ambae infimae sub sinu anastomosantes; stipites sporangiorum glandulas elongatas non ferentes.

Type species: *Polypodium patens* Sw., Nov. Gen. et Sp. Pl. Prodr.: 133 (1788).

1–6 pairs very small reduced pinnae at base of frond; costules 2–3 mm apart:

Frond c. 30 cm long excluding reduced pinnae; lamina between veins on both surfaces glabrous 7. *C. guineensis*

Frond c. 50–60 cm long excluding reduced pinnae; lamina between veins of lower surface bearing acicular and capitate hairs 8. *C. friesii*

One or more pairs lower pinnae gradually reduced; costules 3–4 mm or more apart;

Pinnae to 4×1 cm 9. *C. multifrons*

Pinnae much larger:

Largest pinnae bearing separately adnate pinnules near their bases . . . 10. *C. afzelii*

Largest pinnae pinnatifid, no free pinnules:

Pinnae lobed to $3\frac{1}{2}$ mm from costa; indusia glabrous 11. *C. callensis*

Pinnae lobed more deeply; indusia bearing capitate and/or acicular hairs:

Indusia and lower surfaces generally bearing copious \pm yellow capitate hairs and a few short acicular hairs 12. *C. microbasia*

Indusia and lower surfaces bearing more acicular than capitate hairs:

Pinnae lobed to 1–1½ mm from costa; upper surface between veins bearing short acicular hairs:

Caudex erect 13. *C. gueintziana*

Caudex decumbent 14. *C. chaseana*

Pinnae lobed to 2–2½ mm from costa; upper surface between veins glabrous or nearly so 15. *Dryopteris pseudogueintziana*.

7. **Christella guineensis** (Chr.) Holtt., comb. nov.—*Dryopteris guineensis* Chr. in Journ. de Bot. **22**: 22 (1909).—*Thelypteris guineensis* Alston in Bull. Brit. Mus. (Nat. Hist.) Bot. **1**: 48 (1952); Ferns W. Trop. Afr.: 61 (1959). Type: Guinea, Labé, *Chevalier 12*, 385 (P !).

Caudex short-creeping; stipe to 30 cm, stramineous, minutely hairy; lamina 30–45 cm long, at base abruptly reduced to 1–4 pairs pinnae c. 1 cm long or less. Largest pinnae to 10.5 × 1.6 cm, base not auricled, acuminate, lobed to less than 1 mm from costa; lobes slightly falcate, tips rounded with an apiculus; costules 2½ mm apart; veins 9–10 pairs; lower surface of costae and costules with sparse spreading hairs to ½ mm long, few on costules, a few capitate hairs on costules, no others; upper surface hairy on costa, sparse hairs on costules and veins, not between veins. Sori medial; indusia small, bearing short capitate hairs only.

Distribution: Sierra Leone, Guinea, Nigeria.

8. **Christella friesii** (Brause) Holtt., comb. nov.—*Dryopteris friesii* Brause in R. E. Fries, Wiss. Ergebn. Schwed. Rhod.-Kongo Exp. Bot. **1**: 1 (1914).—*Thelypteris friesii* Schelpe in Bol. Soc. Brot. Ser. 2, **41**: 216 (1967); Fl. Zamb. Pterid.: 192 (1970). Type: Zambia, Luvingo, *R. E. Fries 1104* (UPS).

Caudex short-creeping; stipe 30 cm or more long, pale, short-hairy in groove; lamina to c. 70 cm long, basal 5–6 pairs of pinnae much reduced, some lower large pinnae deflexed. Largest pinnae 10–16 × 1.7–2.0 cm, base truncate, apex acuminate, lobed to less than 1 mm from costa; costules 2½–3 mm apart; veins 8–12 pairs; lower surface of rachis, costae, costules and veins bearing slender spreading pale hairs, on lamina between veins slender erect acicular and short capitate hairs; upper surface hairy on costa, sparsely on costules and veins, very short hairs also on and between veins. Sori small, medial; indusia small, bearing acicular and capitate hairs.

Distribution: Congo, Cameroons, Tanzania, Kenya, Zambia, Malawi, Rhodesia.

9. **Christella multifrons** (C. Chr.) Holtt., comb. nov.—*Dryopteris multifrons* C. Chr. in Bonap. Notes Pterid. **16**: 172, Pl. IIB (1915); Dansk. Bot. Ark. **7**: 47 (1932).—*Thelypteris multifrons* Ching in Bull. Fan Mem. Inst. Biol. Bot. **10**: 252 (1941); Tard. in Humbert, Fl. Madag. 5e Fam. **1**: 281, fig. xl. 1–3 (1958). Type: Madagascar, *Perrier 11*, 538 (P !).

Caudex short-creeping; stipes 25–35 cm long, stramineous; lamina 30 cm long, pinnae 8–12 pairs, $2\frac{1}{2}$ –3 cm apart; lower pinnae slightly shorter and more widely spaced. Largest pinnae 3.7×0.8 –1.0 cm; base broadly unequally cuneate (basal acroscopic segment 7 mm long, basiscopic 5 mm), short-acuminate, lobed to 1 mm from costa, basal acroscopic lobe sometimes almost free; lobes oblique, separated by rounded sinuses where fertile; costules 4 mm apart; veins 3–4 pairs (5 pairs in basal acroscopic lobe); lower surface of rachis, costae and costules rather sparsely short-hairy, sparse short erect hairs between veins; upper surface hairy on costa, hairs on costules and veins few, short. Sori a little inframedial; indusia rather large, short-hairy.

Only known from type collection.

10. **Christella afzelii** (C. Chr.) Holtt., comb. nov.—*Dryopteris afzelii* C. Chr. in Ark. for Bot. 14, no. 19: 2, pl. 1 (1916); Dansk. Bot. Ark. 7: 47, pl. 11, fig. 1–4 (1932).—*Thelypteris afzelii* Tard. in Humbert, Fl. Madag. 5e Fam. 1: 282 (1958). Type: Madagascar, *Afzelius & Palm* 480 (P !).

Caudex short-creeping; stipe 40 cm; lamina 40–60 cm long, middle pinnae $3\frac{1}{2}$ cm apart, lower somewhat reduced and to 7 cm apart. Largest pinnae 12×1.5 –2.5 cm, costa bearing up to 7 pairs free adnate segments in basal part, a pinnatifid lamina distally; veins in free segments to 9 pairs, some forked; lower surface of rachis and costae bearing spreading hairs, hairs on costules shorter, \pm antrorse, slender erect hairs on surface between veins; upper surface hairy on costa, scattered long hairs on costules and veins. Sori medial, sometimes on both branches of lower veins; indusia short-hairy.

Distribution: Madagascar, known from two collections.

11. **Christella callensii** (Alston) Holtt., comb. nov.—*Cyclosorus callensii* Alston in Bol. Soc. Brot. Ser. 2, 30: 13 (1956).—*Thelypteris callensii* Reed in Phytologia 17: 266 (1968). Type Congo, Zongo, *Callens* 2861 (BM !).

Stipe 20 cm long, densely covered with hairs 1 mm long; lamina 35 cm long, pinnae 16 pairs, basal pinnae slightly reduced, narrowed in basal $1\frac{1}{2}$ cm. Largest pinnae 9×1.7 cm, base truncate, acuminate, lobed to $3\frac{1}{2}$ mm from costa; lobes hardly falcate; costules 4 – $4\frac{1}{2}$ mm apart, at wide angle to costa; veins 7 pairs; lower surface of rachis densely hairy, costae and costules with scattered pale hairs over $\frac{1}{2}$ mm long and shorter ones, short hairs on veins; copious long pale hairs on upper surface of costae and costules and sparsely on veins. Sori medial, indusia large, glabrous.

Only known from type collection, found among rocks near a waterfall.

12. **Christella microbasis** (Bak.) Holtt., comb. nov.—*Nephrodium microbasis* Bak., Syn. Fil. ed. 2: 496 (1874).—*Dryopteris microbasis* Kuntze, Rev. Gen. Pl. 2: 813 (1891).—*Thelypteris microbasis* Tard. in Mem. Inst. Fran. Afr. Noire

28: 117, t. 20 f. 1 (1953); Alston, Ferns W. Trop. Afr.: 61, 80 (1959).—*Lastrea microbasis* Pic. Serm. in Webbia **23:** 175 (1968). Type: Nigeria, Barter (K !).

Dryopteris adenochlamys C. Chr. in Fedde Repert. 9: 370 (1911). Type: Guinea, Fouta Djallon, Pobéquin 9 (P !).

Caudex short-decumbent; stipe 50–60 cm long, stramineous; lamina 50–60 cm long, 2–3 pairs basal pinnae reduced, lowest 2,5 cm long. Largest pinnae $12 \times 1,8$ cm (fertile a little narrower), basal acroscopic segment somewhat elongate and widened, sometimes crenate; apex acuminate; lobed to 1 mm from costa; costules 3–4 mm apart; veins 8–10 pairs; lower surface of rachis, costae, costules and veins bearing hairs on varying length, to 1 mm long, on all parts of lower surface abundant short capitate hairs, often yellowish; long hairs abundant on costae of upper surface, scattered on costules and veins, a few acicular and capitate hairs between veins. Sori a little supramedial; indusia bearing copious short capitate hairs and a few acicular hairs.

Distribution: Guinea, Ivory Coast, Sierra Leone, Nigeria, Mali, Angola; single specimens from Kenya and Tanzania differ in presence of many anastomosing basal veins. A plant examined cytologically by Manton was tetraploid (see Alston, 1959: 80).

13. Christella gueinziana (Mett.) Holtt., comb. nov.—*Aspidium gueintzianum* Mett., Farngett. IV: 83 (1858).—*Lastrea gueintziana* Moore, Ind. Fil.: 93 (1858).—*Nephrodium gueintzianum* Hieron. in Engl. Bot. Jahrb. **28:** 341 (1900).—*Dryopteris gueintziana* C. Chr., Ind. Fil.: 269 (1905).—*Thelypteris gueinziana* Schelpe in Journ. S. Afr. Bot. **31:** 262, 264 (1965); Fl. Zamb. Pterid.: 194 (1970). Type: Natal, Gueinzus (B).

Dryopteris prolixa sensu C. Chr., Dansk. Bot. Ark. **7:** 45 (1932); *Thelypteris prolixa* sensu Tard. in Humbert, Fl. Madag. 5e Fam. **1:** 280, fig. xxxix, 8–10 (1958); not *Aspidium prolixum* Willd.

Caudex erect; stipe to 30 cm, stramineous, basal scales to 4 mm long; lamina 60–90 cm long, 1 or more pairs lower pinnae gradually reduced, deflexed and auricled. Largest pinnae commonly $12 \times 1,8$ cm (exceptionally to $20 \times 2,4$ cm), auricled at acroscopic base, auricle crenate or lobed; narrowly acuminate; lobed to $1\frac{1}{2}$ mm from costa, lobes falcate; costules commonly 4 mm apart; veins 8–10 (–15) pairs; lower surface of rachis, costae, costules and veins bearing short spreading acicular hairs, short capitate hairs also present on all parts; upper surface hairy on costae, sparsely on costules, with short stiff suberect hairs between veins. Sori medial; indusia bearing both short acicular and capitate hairs.

Distribution: Madagascar, S. Africa, Mozambique, Rhodesia, Malawi, Tanzania, Kenya, Ethiopia, Sudan, Angola. Specimens from St Helena, lacking caudex, belong to this species or to *C. chaseana*.

14. **Christella chaseana** (Schelpe) Holtt., comb. nov.—*Thelypteris chaseana* Schelpe in Journ. S. Afr. Bot. **31**: 263 (1965); Fl. Zamb. Pterid.: 194 (1970).—*Lastrea chaseana* Pic. Serm. in Webbia **23**: 175 (1968). Type: S. W. Africa, Otjiwarongo Distr., *Schelpe 4791* (BOL).

Caudex creeping; stipes to 60 cm long, basal scales to 11 mm long; lamina much as in *C. gueintziana*, but sterile pinnae sometimes lobed less deeply with basal veins sometimes anastomosing below the sinus.

Distribution: S.W. Africa, Angola, Congo, W. Cameroons, Uganda, Kenya, Tanzania, Malawi, Zambia, Rhodesia.

This species is very near *Thelypteris conspersa* (Schrad.) A. R. Smith in Univ. Cal. Publ. Bot. **59**: 60 (1971) of South America.

15. **Dryopteris pseudogueintziana** Bonap. in Bull. Jard. Bot. Brux. **4**: 4 (1913).—*Thelypteris pseudogueintziana* Alston, Ferns W. Trop. Afr.: 61 (1959) excl. syn. *Dryopteris membranifera* C. Chr. Type: Congo, Kitobola, *A. Flamigni* (P !).

Caudex erect or suberect with tufted fronds; stipe 25 cm long, lamina 50 cm long, pinnae 20 pairs; lowest pair pinnae 5 and 7½ cm long, deflexed, shortly auricled on acroscopic side, auricle crenate or not. Largest pinnae 11.5 × 1.8 cm, lobed to 2–2½ mm from costa; costules to 4 mm apart; veins 9–10 pairs, no anastomosis of basal veins observed; lower surfaces of rachis, costae and costules bearing minute acicular and a few short capitate hairs, none between veins; hairs on upper surface of costa more than ½ mm long, scattered also on costules and veins, hairs between veins few. Sori a little supramedial; indusia with a few short acicular and some capitate hairs.

Only known from type collection, above described; differs from *C. gueintziana* in less deeply lobed pinnae, shorter and more sparse pubescence on both sides and doubtfully in supramedial sori. These differences might be due to an unusually shady environment.

8. *STEGNOGRAMMA* Blume

Enum. Pl. Jav.: 172 (1828), emend. K. Iwatsuki, in Acta Phytotax. Geobot. **19**: 112–126 (1963).

Caudex short-creeping or erect; stipes densely hairy, hairs unicellular or septate (unicellular in African species); fronds simply pinnate, basal pinnae not or little reduced; spherical glands lacking; veins free or with goniopteroid anastomosis; sori exindusiate, running along veins; sporangia copiously setiferous; spores with many small wings; chromosome number 36.

About 15 species, throughout warmer parts of the Old World, with a few (not yet clearly distinguished) in tropical America. Iwatsuki has united here *Leptogramma* J. Sm. and *Dictyocline* Moore; the arrangement appears to be a natural one.

1. *Stegnogramma pozoi* (Lagasca) K. Iwats. in Acta Phytotax. Geobot. **19**: 124 (1963).—*Hemionitis pozoi* Lagasca, Nov. Gen. Sp.: 33 (1816).—*Gymnogramme pozoi* Desv. in Mem. Soc. Linn. Paris **6**: 216 (1827).—*Pleurosorus pozoi* Trevisan in Atti Soc. Ital. Sci. Nat. **17**: 256 (1875).—*Ceterach pozoi* A. Braun ex Milde in Bot. Zeit. **24**: 310 (1866).—*Thelypteris pozoi* Morton in Bull. Soc. Bot. France **106**: 234 (1959); Schelpe, Fl. Zamb. Pterid.: 199 (1970).—*Leptogramma pozoi* Heywood in Fedde Repert. **64**: 19 (1961). Type: Northern Spain, D. G. del Pozo (S-PA).

Polypodium tottum Willd. in Linn. Sp. Pl. ed. IV, **5**: 201 (1810), non Thunb. 1800.—*P. africanum* Desv. in Mem. Soc. Linn. Paris **6**: 239 (1827), nom. nov.—*Dryopteris africana* C. Chr., Ind. Fil.: 250, p.p. (1905); Sim, Ferns S. Afr. ed. **2**: 25, pl. 23 (1915).—*Lastrea africana* Ching in Contr. Biol. Lab. Sci. Soc. China **9**: 36 (1933).—*Leptogramma africana* Nakai ex Mori, Enum. Pl. Corea: 13 (1922).—*Lastrea africana* Copel., Gen. Fil.: 138 (1947). Type: South Africa, Herb. Willd. no. 19, 697 (B !).

Gymnogramma totta Schlechtend., Adumbr. Fil. Prom. B. Spei: 15, t. 6 (1825).—*Grammitis totta* Presl, Tent. Pterid.: 209 (1836).—*Leptogramma totta* J. Sm. in Hook. J. Bot. **4**: 52 (1841).—*Phegopteris totta* Mett., Farngett. IV: 18 (1858).—*Aspidium tottum* Engl., Hochgebirgsl. Trop. Afr. (1892) 99.—*Nephrodium tottum* Diels in Engl. & Prantl, Nat. Pflanz. fam. **1**, Abt. **4**: 170 (1899).—*Dryopteris totta* Masum. in Mem. Fac. Sci. Agric. Taihoku Univ. **11**: 58 (1934).—*Lastrea totta* Ohwi in Bull. Nat. Sct. Mus. Tokyo **3**: 98 (1934). Type: Cape Peninsula (HAL).

Acrostichum pilosiusculum Wikstr. in K. Vet. Acad. Handl. 1825: 439 (1826).—*Leptogramma pilosiuscula* Alston in Bol. Soc. Brot. Ser. **2**, **30**: 17 (1956); Ferns W. Trop. Afr.: 63 (1959). Type: Madeira, Masson (BM).

Gymnogramma lowei Hook. & Grev., Ic. Fil.: t. 89 (1829). Type: Madeira, Lowe (E).

Caudex short, erect; stipe to 25 cm long, stramineous, basal scales thin and densely hairy; lamina 25–45 cm long, several pairs upper pinnae adnate to rachis; basal pinnae somewhat reduced, narrowed towards base especially on basiscopic side. Largest pinnae $6 \times 1,5$ to $12 \times 2,5$ cm, base truncate, not dilated, apex short-acuminate, lobed to 2–3 mm from costa; costules 4–6 mm apart; veins 6–8 pairs, usually simple, basal acroscopic vein to side of sinus-membrane, basiscopic to edge; lower surface of rachis, costae and costules bearing stiff pale hairs to 1 mm long, shorter hairs on veins; appressed slender hairs to $\frac{1}{2}$ mm long all over upper surface. Sori occupying middle part of each vein, c. 2 mm long; sporangia setose.

Distribution: northern Spain, Madeira, Azores, widely in tropical Africa, South Africa, Comoro Islands. Plants in the region India to Japan have been

regarded by Ching as representing a distinct species, by Iwatsuki (l.c. 1963, p. 125) as *S. pozoi* subsp. *mollissima* (Fischer ex Kunze) K. Iwats.

9. *THELYPTERIS* Schmidel

Ic. Pl. ed. Keller: 45, t. 11, 13 (1763).

Rhizome slender, growing in wet ground, branching, fronds widely spaced; scales broad, thin, not hairy; lamina bipinnatifid, basal pinnae not or little reduced; veins all free, often forked, running to margin; flat thin scales present on lower surface of costae (also filamentous smaller ones); unicellular acicular and capitate hairs sometimes present on lamina but not sessile spherical glands; sori indusiate; short capitate hairs sometimes present on sporangia (not seen on African species); spores with irregularly spiny exine and no perine. Chromosome number 35.

Two or three species; one or two in north temperate regions, one in isolated areas mostly south of the equator.

1. *Thelypteris confluens* (Thunb.) Morton in Contr. U.S. Nat. Herb. **38**: 71 (1967); Schelpe, Fl. Zamb. Pterid.: 190, tab. 55E (1970).—*Pteris confluens* Thunb., Prodr. Fl. Cap.: 171 (1800). Type: S. Africa, *Thunberg* (UPS).

Aspidium thelypteris var. *squamigerum* Schlechtend., Adumb. Fil. Prom. B. Spei: 23, t. 11 (1825).—*Aspidium squamigerum* Fée, Mem. Fam. Foug. **8**: 104 (1857).—*Lastrea thelypteris* var. *squamigera* Bedd., Handb. Ferns Br. India Suppl.: 54 (1892).—*Dryopteris thelypteris* var. *squamigera* C. Chr., Ind. Fil.: 297 (1905).—*Thelypteris palustris* var. *squamigera* Weath. in Contr. Gray Herb. n.s. **73**: 40 (1924).—*Thelypteris squamigera* (err. typ. *squamulosa*) Ching in Bull. Fan Mem. Inst. Biol. Bot. **6**: 329 (1936); Tard. in Humbert, Fl. Madag. 5e Fam. **1**: 282 (1958). Type: Cape Peninsula (HAL).

Nephrodium squamulosum Hook. f., Fl. New Zeal. **2**: 39 (1855).—*Nephrodium thelypteris* var. *squamulosum* Hook., Spec. Fil. **4**: 88 (1862). Type: New Zealand, *Colenso* (K !).

Lastrea fairbankii Bedd., Ferns Br. India: t. 254 (1867); Handb. 240 (1883). Type: Pulney Hills, S. India, *Beddome* (K !).

Rhizome 2 mm diameter; stipe stramineous, 15–50 cm long; lamina 25–50 cm long, pinnae to 20 or more pairs, dimorphous; sterile pinnae to 15 mm or more wide, fertile commonly 6–9 mm wide; lowest pinnae slightly reduced, sometimes with free basal acroscopic segment; middle pinnae not dilated at base, lobed to less than 1 mm from costa; veins in sterile fronds mostly forked, in fertile sometimes simple; lower surface of costae bearing slender hairs and ovate-orbicular flat scales with short hairs on edges; lower surface of lamina bearing a variable number of slender acicular and/or short capitate hairs; upper surface short-hairy on costa. Sori near costules; indusia bearing short hairs on edges.

Distribution: Madagascar, Africa south of the equator and to 7° N. in Ethiopia and Sudan; S. India, N. Thailand, Sumatra, New Guinea, New Zealand.

10. *CYCLOSORUS* Link

Hort. Berol. 2: 128 (1833); Holttum in Blumea 19: 27 (1971).

Similar to *Thelypteris* in long-creeping rhizome growing in wet ground, lower pinnae not reduced, flat scales on lower surface of costae and in spores; differing in anastomosing veins, in presence of spherical glandular cells at ends of hairs on stalks of sporangia and often on lower surface of lamina, and in chromosome number 36.

This genus, as above restricted, is pantropic in distribution (and extra-tropical in southern hemisphere); it comprises a complex of forms the inter-relationships of which cannot be established without extensive cytotaxonomic investigation. For convenience, three species are here recognized, but intermediates exist. The synonymy is complex, and without a guide from experimental work much of it is uncertain. It is thus here reduced to a minimum, but attention must be called to the fact that many other binomials have been published, based on specimens from many parts of the world. Apart from *C. striatus*, peculiar to Africa, the name *Cyclosorus gongylodes* (Schkuhr) Link has been applied in recent years by most authors to all specimens; recently the situation has been complicated by the discovery of first one and then another earlier name. In the 19th century the name *Nephrodium unitum* was commonly used, based on *Polypodium unitum* Linn. because at least one reference cited by Linnaeus certainly referred to a plant of *Cyclosorus* in the present sense, but the Linnean type represents the species described in the present paper as *Sphaerostephanos unitus*.

Pinnae lobed $\frac{3}{4}$ or more towards costa, commonly 2½–3 cm wide; lower surface of costules bearing abundant very small scales 1. *C. striatus*

Pinnae lobed less deeply, rarely to 2 cm wide; lower surface of costules glabrous or bearing acicular and/or capitate hairs, often also spherical glands:

Pinnae quite hairless and eglandular beneath, very firm 2. *C. tottus*

Pinnae variously hairy and glandular beneath, usually thinner 3. *C. interruptus*

1. *Cyclosorus striatus* (Schum.) Ching in Bull. Fam. Mem. Inst. Biol. Bot. 10: 249 (1941); Alston, Ferns W. Trop. Afr.: 62 (1959).—*Aspidium striatum* Schum. in K. Dansk. Vidensk. Selsk. 4: 230 (1829).—*Dryopteris striata* C. Chr., Ind. Fil.: 294 (1905).—*Thelypteris striata* Schelpe in Journ. S. Afr. Bot. 31: 268 (1965); Fl. Zamb. Perid.: 199 (1970). Type: Guinea (C).

Polypodium pallidivenium Hook., Spec. Fil. 5: 8 (1863).—*Nephrodium pallidivenium* Bak., Syn. Fil.: 290 (1867).—*Dryopteris pallidivenia* Kuntze, Rev. Gen. Pl. 2: 813 (1891). Type: Sierra Leone, Mann 909 (K !).

Rhizome c. 5 mm diameter; stipe to 60 cm or more long, basal scales dark; lamina to 100 cm or more long, texture very firm; basal pinnae narrowed towards their bases; largest pinnae commonly 20×2.5 cm, base truncate, apex evenly attenuate, lobed to about 2 mm from costa, lobes dentate; costules 5–6 mm apart; veins to 20 pairs or more, basal 1 pair anastomosing, next pair to sides of membrane; costae usually hairless beneath but with \pm persistent rather dark acuminate scales, costules more persistently covered with small scales, some filiform; upper surface of costa sparsely short-hairy. Sori medial, lower ones divergent; indusia small, glabrous; a red gland sometimes present at end of a hair on stalk of a sporangium.

Distribution: widespread in tropical Africa.

2. *Cyclosorus tottus* (Thunb.) Pic. Serm. in Webbia **23**: 173 (1968).—*Polypodium tottum* Thunb., Prodr. Pl. Cap.: 172 (1800).—*Thelypteris totta* Schelpe in Journ. S. Afr. Bot. **29**: 91 (1963); Fl. Zamb. Pterid.: 198 (1970) p.p.—*T. totta* var. *totta* A. R. Smith in Univ. Cal. Publ. Bot. **59**: 54 (1971). Type: S. Africa, Thunberg (UPS).

Differs from *C. striatus*: pinnae smaller, rarely to 2 cm wide, lobed about $\frac{1}{2}$ way to costa or less deeply; veins 10–12 pairs; scales on lower surface of costae pale brown, often ovate-acute; small or filiform scales rare on costules.

Distribution: South Africa; occurrence in tropical Africa needs further study. *Cyclosorus gongylodes* (Schkuhr) Link, type from Guyana, is very similar, also specimens from Jamaica shown by T. G. Walker to be tetraploid (Trans. R. Soc. Edinb. **66**: 179; 1966). A. R. Smith has also found tetraploid plants in Florida.

3. *Cyclosorus interruptus* (Willd.) H. Ito in Bot. Mag. Tokyo **51**: 714 (1937), nomen tantum.—*Pteris interrupta* Willd. in Phytographia **1**: 13, t. 10, f. 1 (1794).—*Thelypteris interrupta* K. Iwats. in Journ. Jap. Bot. **38**: 314 (1963), nomen tantum; Fosberg & Sachet in Smiths. Contr. Bot. **8**: 8 (1972).—*Aspidium obtusatum* sensu Willd. in Linn. Sp. Pl. ed. IV, **5**: 241 (1810). Type: S. India, Klein (Herb. Willd. no. 19, 770 B!).

Aspidium obtusatum Sw. in Schrad. Journ. Bot. 1800 (2): 33 (1801); Syn. Fil.: 248 (1806). Type: Java, Thunberg (fragm. BM!).

Cyclosorus gongylodes sensu Alston, Ferns W. Trop. Afr.: 62 (1959) p.p.; sensu Tard. in Humbert, Fl. Madag. 5e Fam. **1**: 288 (1958) p.p.

Thelypteris totta sensu Schelpe, Fl. Zamb. Pterid.: 198 (1970) p.p.

Differs from *C. tottus*: texture thinner; lower surfaces variously hairy; large red glands also often present.

Distribution in Africa uncertain. Manton found that a Ceylon plant, indistinguishable from Willdenow's south Indian type, was diploid (Phil. Trans. R. Soc. Ser. B, **238**: 138; 1954). Manton also found that a plant from Tanzania

was diploid (Alston 1959: 80). Hairiness is very variable among specimens from Africa and Asia. Two different diploid genomes may exist, and there is the possibility that triploids may also occur; such plants, though sterile, could continue to grow for an indefinite period owing to the rhizomatous habit.

In 1933 Ching wrongly identified Willdenow's type with a quite different species which is widely distributed in Asia and Malesia (only known from Fernando Po in Africa, described in the present paper as *Amphineuron terminans*). The name *Cyclosorus interruptus* subsequently came into general use for this other species until the mistake was discovered by Fosberg and Sacht.

11. *AMPELOPTERIS* Kunze

Bot. Zeit. 6: 114 (1848).

Fronds of indefinite apical growth, bearing many buds on rachis which form new plants freely; forked unicellular hairs present on rachis; pinnae subentire; veins almost all anastomosing, with few residual free veins running to margin; sori exindusiate, round or somewhat elongate along veins; hairs on stalks of sporangia bearing a terminal glandular cell; chromosome number 36.

One species, distributed throughout tropics of the Old World. This is the only Old World species which has forked unicellular hairs of the type characteristic of the New World genus *Goniopteris*. Its differences from *Goniopteris* are discussed in Holttum, Sen and Mittra, *Blumea* 18: 196, 214 (1970).

1. *Ampelopteris prolifera* (Retz.) Copel., Gen. Fil.: 144 (1947); Alston, Ferns W. Trop. Afr.: 63 (1959); Schelpe, Fl. Zamb. Pterid.: 200, tab. 56 (1970); Tard. in Humbert, Fl. Madag. 5e Fam. 1: 300 (1958).—*Hemionitis prolifera* Retz., Obs. Bot. 6: 38 (1971).—*Meniscium proliferum* Sw., Syn. Fil.: 19, 207 (1806); Hook., 2nd Cent. Ferns: t. 15 p.p. (1861).—*Goniopteris prolifera* Presl, Tent. Pterid.: 183 (1836).—*Nephrodium proliferum* Keys., Pol. Cyath. Hb. Bung.: 49 (1873).—*Dryopteris prolifera* C. Chr., Ind. Fil.: 286 (1905); Sim, Ferns S. Afr. ed. 2: 99, t. 14 (1915).—*Cyclosorus proliferus* Tard. & C. Chr. in Notul. Syst. 14: 346 (1952); Tard. in Mem. Inst. Fr. Afr. Noire 28: 128, pl. 22, fig. 11–13 (1953).—*Polypodium luxurians* Kunze in Linnaea 23: 280 (1850), nom. nov. (not *P. proliferum* Kaulf.).—*Phlegopteris luxurians* Mett., Farngatt. IV: 25 (1858). Type S. India, Koenig (GOET).

Ampelopteris elegans Kunze in Bot. Zeit. 6: 114 (1848). Type: Java, Zollinger 2360 (G !).

The small complete plant figured (as *Menicium proliferum*) by Hooker in 2nd Cent. Ferns, t. 15, also fig. 2 on the same plate, represents *Meniscium hosei* Bak. from Sarawak (*Pronephrium hosei* Holtt., *Blumea* 20: 120. 1972).

Ampelopteris prolifera occurs throughout the wetter parts of tropical Africa, and in the Mascarene Islands.

12. *MENISORUS* Alston

Bol. Soc. Brot. Ser. 2, **30**: 20 (1956).

Caudex erect, short; frond simply pinnate with serrate pinnae, basal ones not reduced, apical lamina with a bud at its base; veins anastomosing; glabrous except upper surface of rachis and costae; sori exindusiate, spreading along veins; sporangia not setose; spores monolete with short laesura, or spherical, surface minutely papillose.

One species, widely distributed through tropical Africa on rocky stream banks.

1. *Menisorus pauciflorus* (Hook.) Alston in Bol. Soc. Brot. Ser. 2, **30**: 20 (1956); Ferns W. Trop. Afr.: 63 (1959).—*Meniscium pauciflorum* Hook., Spec. Fil. **5**: 164 (1864).—*Phegopteris pauciflora* Mett. ex Kuhn, Fil. Afr.: 123 (1868).—*Dryopteris pauciflora* C. Chr., Ind. Fil.: 283 (1905).—*Cyclosorus pauciflorus* Ching in Bull. Fan Mem. Inst. Biol. Bot. **10**: 247 (1941).—*Thelypteris pauciflora* Reed in Phytologia **17**: 302 (1968). Type: Cameroons, Sierra del Crystal, Mann 1672 (K !).

Polypodium prionodes C. H. Wright in Kew Bull. 1906: 253. Type: Uganda, Dawe 369 (K !).

Stipe 10–30 cm, basal scales broadly ovate, not hairy; lamina to 50 cm long, pinnae 15–25 pairs, apical lamina widened and lobed towards its base; pinnae commonly 6–9 cm long, 5–6 mm wide (type of *P. prionodes* 14 × 1 cm), edges serrate; costules 2½ mm apart, very oblique; veins 2 pairs; a few narrow scales on lower surface of costae; sori spreading all along first pair of veins.

Distribution: Congo, Cameroons, Sudan, Kenya, Uganda, Angola.

The spherical spores of this species, with scattered minute superficial papillae, closely resemble those of *Trigonospora* of S.E. Asia (Holttum, Blumea **19**: 29; 1971).

13. *PNEUMATOPTERIS* Nakai

Bot. Mag. Tokyo **47**: 179 (1953); Holtt., Blumea **19**: 42 (1971).

Caudex usually erect, in a few species creeping; scales usually broad, thin, with a few marginal hairs; very young fronds often covered with mucilage; stipe and lamina never conspicuously hairy; basal pinnae abruptly reduced, often many pairs; aerophores at bases of pinnae distinct, often ± swollen; lamina ± pustular when dry; veins anastomosing in all African species; superficial spherical glands lacking; sporangia sometimes bearing capitate hairs, rarely short acicular hairs, near annulus; on sporangium-stalks a hair of 2–4 cells, end cell swollen, rarely coloured; spores bearing many small wings.

More than 70 species, from W. Africa to Hawaii and Queensland, some in Malesia having free veins. A monograph of this genus, including the African species, is in course of publication in Blumea.

There are some aberrant species which I have felt obliged to include here. *P. afra* has setiferous sporangia, narrow hairy stipe-scales and spores irregularly winged; it is a tetraploid, and probably of hybrid origin. *P. unita* (*Goniopteris patens* Fée) has no reduced basal pinnae and aberrant spores, but it has the thin broad scales and pustular lamina normal in *Pneumatopteris*; the closely related *P. subpennigera*, similar in frond-form, does have spores like those normal in *Pneumatopteris*.

Indusia lacking:

Lowest pinnae not or little reduced:

A bud present near apex of rachis; sori mostly \pm circular:

Pinnae lobed $\frac{1}{2}$ – $\frac{3}{4}$, basal pinnae auricled; apical lamina not pinna-like 1. *P. unita*

Pinnae crenate, basal pinnae not auricled; apical lamina pinna-like

2. *P. blastophora*

No bud on rachis; sori elongate along veins 3. *P. subpennigera*

Lower 2–3 pairs pinnae gradually reduced 4. *P. oppositifolia*

Indusia present:

Rhizome wide-creeping; sporangia setose:

Pinnae crenate; 4–6 pairs veins anastomosing 5. *P. afra*

Pinnae lobed $\frac{1}{2}$ or more; 2 pairs veins anastomosing 5a. hybrids

Rhizome erect or short-creeping; sporangia not setose:

Pinnae lobed distinctly less than $\frac{1}{2}$ way to costa:

Lower surface bearing short hairs at least on costae:

Pinnae rigid with thick pale veins, to 3 cm wide, lobed to depth of $2\frac{1}{2}$ –3 mm

6. *P. humbertii*

Pinnae thin, with slender veins, not over $2\frac{1}{2}$ cm wide, lobed to depth of 4–5 mm

7. *P. remotipinna*

Lower surface of pinnae quite glabrous 8. *P. usambarensis*

Pinnae lobed at least $\frac{1}{2}$ way to costa:

Indusia glabrous; no capitate hairs on sporangia:

Lower pinnae narrowed towards an abruptly dilated base 9. *P. venulosa*

Lower pinnae narrowed to a not-dilated base 10. *P. prismatica*

Indusia long-hairy; capitate hairs present on sporangia 11. *P. comorensis*.

1. *Pneumatopteris unita* (Kunze) Holtt., comb. nov.—*Gymnogramma unita* Kunze in Linnaea 18: 115 (1844).—*Phegopteris unita* Mett., Farngett. IV: 22 (1858).—*Polypodium unitum* Hook., Spec. Fil. 5: 5 (1863), non Linn.—*Goniopteris unita* J. Sm., Hist. Fil.: 192 (1875).—*Goniopteris silvatica* Pappe & Rawson, Syn. Fil. Afr. Austr.: 39 (1858), nom. nov. superfl.—*Dryopteris silvatica* C. Chr.; Ind. Fil.: 292 (1905); Sim, Ferns S. Afr. ed. 2: 100, t. 15 (1915), not *D. unita* (L.) Kuntze.—*Cyclosorus silvaticus* Ching in Bull. Fan Mem. Inst. Biol. Bot. 10: 249 (1941).—*Thelypteris silvatica* Reed in Phytologia 17: 313 (1968). Type: Natal, *Gueinzus* (not seen).

Goniopteris patens Fée, Gen. Fil.: 253 (1852).—*Nephrodium patens* J. Sm., Hist. Fil.: 208 (1875) non Desv. 1827.—*Cyclosorus patens* Copel., Gen. Fil.: 143 (1947); Alston, Ferns W. Trop. Afr.: 62 (1959). Type: Natal, *Gueinzus* (not seen).

Goniopteris madagascariensis Fée, Gen. Fil.: 251 (1852).—*Aspidium malagassicum* Kuhn, Fil. Afr.: 136 (1868), nom. nov., not *A. madagascariensis* Fée.

—*Dryopteris madagascariensis* C. Chr., Ind. Fil.: 276 (1905).—*Cyclosorus madagascariensis* Ching, l.c. 246 (1941)—*Thelypteris madagascariensis* Schelpe in Journ. S. Afr. Bot. **31**: 267 (1965); Fl. Zamb. Pterid.: 196 (1970). Type: Madagascar, Goudot (not seen).

Nephrodium costulare Bak. in Journ. Linn. Soc. Bot. **16**: 203 (1877).—*Aspidium costulare* Kuhn in v. d. Deckens Reisen 3, **3**: 65 (1879).—*Dryopteris costularis* C. Chr.: Ind. Fil.: 258 (1905). Type: Madagascar, H. Gilpin (K !).

Dryopteris gladiata C. Chr. in Ark. for Bot. 14, no. **19**: 4, t. 1 (1916); Dansk. Bot. Ark. **7**: 52 (1932). Type: Madagascar, Palm & Afzelius (BM !).

Caudex erect; young coiled fronds covered with slime, linear aerophore on stipe white and swollen; stipe to 50 cm; lamina to 150 cm long, basal pinnae slightly reduced, deflexed, auricled on acroscopic side, narrowed on basiscopic. Largest pinnae to 25×3 cm, lobed $\frac{1}{4}$ — $\frac{1}{3}$, costules 5–6 mm apart, veins 8–12 pairs; broad thin scales at first on lower surface of costae which also bear short hairs; a bud present on rachis near apex of frond. Sori near costules, lower spreading a little, exindusiate; spores with continuous wing and cross-wings.

Distribution: Madagascar, Natal, Mozambique, Rhodesia, Malawi, Tanzania, Kenya, Uganda, Congo, Cameroons Mt.

The correct name in *Thelypteris* for this species is *T. madagascariensis* (Fée) Schelpe.

2. *Pneumatopteris blastophora* (Alston) Holtt., comb. nov.—*Cyclosorus blastophorus* Alston in Bol. Soc. Brot. Ser. 2, **30**: 12 (1956); Ferns W. Trop. Afr.: 62 (1959).—*Thelypteris blastophora* Reed in Phytologia **17**: 264 (1968). Type: S. Nigeria, Savory & Keay FHI 25,062 (BM !).

Caudex short-creeping, 5 mm diameter, fronds to 2 cm apart; stipe 30 cm, stramineous, sparsely hairy; lamina 65 cm long, pinnae 12 pairs; basal pinnae not reduced, rather abruptly narrowed to a cuneate base; apical lamina pinna-like but more deeply crenate than pinnae, a bud present at its base. Largest pinnae to 18×3.5 cm, base subtruncate to broadly rounded, apex short-cuspidate, edges crenate; costules 4 – $4\frac{1}{2}$ mm apart, at wide angle to costa; veins to 8 pairs, 4 pairs anastomosing with zig-zag excurrent vein, 2 pairs to sides of sinus-membrane; minute erect hairs on lower surface of rachis and costae; very short hairs on upper surface of rachis and costae. Sori medial (in specimen from Liberia near costules), exindusiate, no hairs nor glands on sporangia; spores not seen.

Distribution: Liberia, Ghana, Fernando Po, Uganda.

Alston identified the Liberian specimen (W. J. Harley, F.188) as *Cyclosorus patens* (*Pneumatopteris unita*), but apart from the position of its sori it agrees closely with the type of *P. blastophora*, notably in crenate pinnae and venation.

3. **Pneumatopteris subpennigera** (C. Chr.) Holtt., *Blumea* **21**: (1974).—*Dryopteris subpennigera* C. Chr. in *Dansk. Bot. Ark.* **7**: 52, pl. 12, fig. 1, 2 (1932).—*Cyclosorus subpennigerus* Ching in *Bull. Fan Mem. Inst. Biol. Bot.* **10**: 249 (1941); Tard. in *Humbert, Fl. Madag. 5e Fam.* **1**: 298 (1958).—*Thelypteris subpennigera* Reed in *Phytologia* **17**: 318 (1968). Type: Madagascar, *Perrier 15,620* (P!, BM).

Differs from *P. unita*: no bud on rachis; sori medial, all elongate along veins; spores with many small wings.

Distribution: Madagascar and Comoro Islands.

4. **Pneumatopteris oppositifolia** (Hook.) Holtt., comb. nov.—*Polypodium oppositifolium* Hook., *Spec. Fil.* **5**: 8 (1863).—*Phegopteris oppositifolia* Kuhn, *Fil. Afr.*: 123 (1868).—*Goniopteris oppositifolia* J. Sm., *Hist. Fil.*: 192 (1875).—*Dryopteris oppositifolia* C. Chr., *Ind. Fil.*: 281 (1905).—*Cyclosorus oppositifolius* Tard. in *Notul. Syst.* **14**: 346 (1953); Alston, *Ferns W. Trop. Afr.*: 62 (1959). Type: San Tomé, *G. Mann* (K!).

Caudex short-creeping; stipe to 75 cm long, near base a swollen linear aerophore, scales small, hairy; lamina 75 cm long, pinnae to at least 30 pairs, opposite, lower 2–4 pairs gradually reduced, lowest $2\frac{1}{2}$ cm long and $2\frac{1}{2}$ cm wide at cordate base, apex of frond not pinna-like, no bud on rachis. Largest pinnae 22×2.3 cm, base auricled and subcordate on acroscopic side, caudate-acuminate, edges crenately lobed to depth of $1\frac{1}{2}$ mm; costules $3\frac{1}{2}$ –4 mm apart; veins 8 pairs, 2 pairs anastomosing, 2 pairs to sides of membrane; lower surface of rachis and costae bearing short stiff hairs, costules and veins sparsely hairy; upper surface hairy only on costa. Sori inframedial, exindusiate, basal ones not divergent; sporangia rarely bearing short setae; spores as *P. unita*.

Distribution: San Tomé, Annobon Island, Fernando Po. This species shows resemblances to both *P. afra* and *P. unita*.

5. **Pneumatopteris afra** (Chr.) Holtt., comb. nov.—*Dryopteris afra* Chr. in *Bull. Soc. Bot. France* **55**, Mem. 8b: 107 (1908).—*Cyclosorus afer* Ching in *Bull. Fan Mem. Inst. Biol. Bot.* **10**: 242 (1941); Alston, *Ferns W. Trop. Afr.*: 63 (1959).—*Thelypteris afra* Reed in *Phytologia* **17**: 258 (1968).—Lectotype: Congo, Haut-Oubangui, *A. Chevalier 5799* (P; K!).

Dryopteris dewevrei Chr. ex Bonap., *Notes Pterid.* **14**: 207 (1924).—*Cyclosorus dewevrei* Adams & Alston in *Bull. Brit. Mus. (Nat. Hist.) Bot.* **1**: 157 (1955). Type: Gabon, *Le Testu 1719* (P).

Caudex wide-creeping, 7 mm diameter, fronds c. 5 cm apart; stipe 35 cm, scales at base narrow, hairy; lamina 120 cm or more long; 2–3 pairs basal pinnae abruptly reduced and strongly auricled, lowest 1–2 cm long; aerophores white and slightly swollen on living fronds. Largest pinnae to 20×2.5 cm, base broadly cuneate, in lower pinnae auricled, apex caudate-acuminate, edges crenate to depth of 2 mm; costules $3\frac{1}{2}$ – $4\frac{1}{2}$ mm apart, at a wide angle to costa;

veins 10–12 pairs, 4–6 pairs anastomosing, sinus-membrane very short; sparse short hairs on lower surface of costae and costules, sometimes between veins; long hairs on upper surface of costae, few on costules. Sori medial; indusia hairy; sporangia bearing 2–3 setae near annulus; hair of 3 cells on sporangium stalk; spores irregularly winged.

Distribution: Guinea, Sierra Leone, Liberia, Ivory Coast, Ghana, Nigeria, Cameroons, Fernando Po, Congo, Angola, Uganda.

5a. Possible hybrids of *P. afra*. In Ghana, where *P. afra* and *Christella dentata* grow near together, Dr J. Ghatak has found a plant which is intermediate between them and shows irregular meiosis. Plants of similar aspect, with pinna lobed $\frac{3}{4}$ – $\frac{2}{3}$, two pairs veins anastomosing and few setose sporangia, have been collected in Liberia (*W. J. Harley F.88*), Sierra Leone (*Morton & Macaulay 1712*), Ghana (*C. D. Adams 539*), Nigeria (*J. B. Hall 46*), Tanzania (*Newbould & Harley 4248*; *Verdcourt 3375*) and Uganda (*Chandler 1691*). Some of these have abortive spores. The following also appear to be possible hybrids of *P. afra*:

Thelypteris dentata var. *buchananii* Schelpe in J. S. Afr. Bot. **31**: 265, fig. 1d (1965), excluding specimens of Buchanan from Natal, which are *Christella altissima*. Type: Mozambique, *Schelpe 5599* (BOL). This is beyond the known range of *P. afra*.

Dryopteris willemannii Chr. in Ann. Mus. Congo, Ser. V, **3**: 35 (1909). Type: Congo, Bena-Dibele, *Flamigni 62* (P!). Pinnae lobed about half-way to costa, to 11 × 2.0 cm, otherwise similar to the other specimens above cited (which have pinnae nearly as those normal for *P. afra*).

6. ***Pneumatopteris humbertii*** Holtt., sp. nov.—*Cyclosorus subpennigerus* (C. Chr.) Tard. in Humbert, Fl. Madag. Polypod. **1**: 298 (1958), p.p.

Caudex ignotus; stipes 20 cm longus usque pinnam reductam infimam; frons usque 100 cm longa. Pinnae inferiores 6-jugatae reductae, infimae 8 mm longae, superiores 2 cm vel ultra longae, basi truncata, 2,2 cm latae; pinnae evolutae inferiores 20 cm longae, 2,5–3,0 cm latae, basin versus non vel paulo angustatae, basi acroscopice non auriculatae, apice acuminatae non caudatae, $\frac{1}{3}$ costam versus lobatae, lobis leviter falcatis, integris, interdum apiculatis; costulae 5 mm inter se distantes, venae 8–10-jugatae, crassae, pallidae, $2\frac{1}{2}$ –3-jugatae anastomosantes, venam excurrentem valde sinuatam facientes; costae subtus pilis brevibus rigidis praesertim distaliter vestitae, costulae venae laminaque pilis brevibus sparsim praeditae; costae supra hirsutae, costulae minute setiferae. Sori mediales, inferiores interdum divergentes at leviter elongati; indusia magna, glabra; sporangia eglandulosa.

Type: MADAGASCAR, partie occidentale du Massif de Marojejy, 1 400 m, *Humbert 31679* (K). Also *Humbert 22465*.

7. **Pneumatopteris remotipinna** (Bonap.) Holtt., comb. nov.—*Dryopteris remotipinna* Bonap., Notes Pterid. **5**: 57 (1917); C. Chr., Dansk. Bot. Ark. **7**: 50, pl. 12, f. 10 (1932).—*Cyclosorus remotipinna* Ching in Bull. Fan Mem. Inst. Biol. Bot. **10**: 248 (1941).—*Thelypteris remotipinna* Reed in Phytologia **17**: 398 (1968). Type: Madagascar, *Perrier 6072* (P !).

Dryopteris longifolia Bonap., Notes Pterid. **5**: 55 (1917), non Hieron. 1907.—*D. sambiranensis* C. Chr. in Perrier, Cat. Pl. Madag.: 25 (1932) nom. nov.; Dansk. Bot. Ark. **7**: 50, pl. 12, f. 11 (1932).—*Cyclosorus sambiranensis* Ching in Bull. Fan Mem. Inst. Biol. Bot. **10**: 248 (1941).—*Thelypteris sambiranensis* Reed in Phytologia **17**: 311 (1968). Type: Madagascar, *Perrier 7665* (P !).

Caudex erect; stipes 25–45 cm long, basal scales thin and flat; frond to 250 cm long with at least 8 pairs reduced and widely spaced lower pinnae, lowest 5–6 mm long, 5th pair 2.5×1.3 cm, triangular, not auricled. Largest pinnae $25\text{--}28 \times 2.0\text{--}2.5$ cm, lobed $\frac{2}{3}$ towards costa, lobes oblong with rounded tips; costules $4\frac{1}{2}$ mm apart; veins 10–11 pairs, $1\frac{1}{2}$ –2 pairs anastomosing, 1 pair to sinus-membrane; some stiff red-brown hairs on lower surface of costae, also short pale hairs on costae, costules and sometimes between veins; upper surface hairy on costae only. Sori near costules, lower ones somewhat divergent; indusia glabrous; sporangia bearing large yellow capitate hairs; red glandular cells at ends of hairs on stalks of sporangia.

Distribution: Madagascar.

Christensen apparently only saw a distal pinna of the type (shown in his pl. 12, fig. 10) but the lower pinnae are much larger. The type has slender erect hairs all over the lower surface, but other specimens are less hairy. The glandular cells on sporangia and on hairs on their stalks are distinctive.

8. **Pneumatopteris usambarensis** Holtt., sp. nov.

Rhizome breve repens; stipes 30 cm longus, basi paleis parvis adpressis vestitus; frons 160 cm longa; pinnae inferiores 3-jugatae 5–8 mm longae, pinnae sequentes $3\frac{1}{2}$, $4\frac{1}{2}$, 10, 15 cm longae, omnes basi truncatae; pinnae maximae 30 cm longae, steriles usque 2,6 cm latae, fertiles 2,3 cm, basi leviter dilatatae, apice acuminatae, $\frac{1}{3}$ – $\frac{2}{5}$ costam versus lobatae, lobis fertilibus subtruncatis leviter dentatis, sterilibus rotundatis integris; costulae 5–5 $\frac{1}{2}$ mm inter se distantes, late patentes; venae 8–10-jugatae, 2-jugatae anastomosantes; pagina inferior omnino glabra. Sori paulo inframediales; indusia tenuia glabra vel pilis paucis praedita; sporangia pilis capitatis ornata.

Type: TANZANIA, E. Usambara Mts, 1 000 m, *Faden et al. 70/293* (EA, one frond on 7 sheets). Also on Usambara Mts *Greenway 4794*; *A. Braun 1427*; *A. Peter 159, 9999, 16859*; *C. Holst 4263, 2266*.

9. **Pneumatopteris venulosa** (Kuntze) Holtt., comb. nov.—*Nephrodium venulosum* Hook., Spec. Fil. **4**: 71 (1862), non Desv. 1827.—*Aspidium elatum* Mett. ex Kuhn, Fil. Afr.: 131 (1866), non Bojer 1837.—*Dryopteris venulosa* Kuntze,

Rev. Gen. Pl. **2**: 814 (1891), nom. nov.—*Dryopteris elata* C. Chr., Ind. Fil.: 263 (1905).—*Cyclosorus elatus* Alston, Bol. Soc. Brot. Ser. 2, **30**: 13 (1956); Ferns W. Trop. Afr.: 63 (1959).—*Thelypteris elata* Schelpe in Journ. S. Afr. Bot. **31**: 265 (1965).—*Thelypteris venulosa* Reed in Phytologia **17**: 323 (1968). Type: Fernando Po, G. Mann (K !).

Stipe to at least 40 cm long; reduced basal pinnae c. 4 pairs, lowest 1,5 cm long, uppermost 5 cm, auricled on acroscopic base. Largest pinnae $20 \times 2,5$ –3,0 cm, lower ones narrowed in basal 4–5 cm and then dilated to basal width 2 cm, acuminate, lobed a little more than $\frac{1}{2}$ way to costa; lobes oblique, oblong, \pm dentate; costules 5 mm apart; veins 9 pairs, lowest pair anastomosing, 1 pair to sinus-membrane; rachis and costae \pm hairy beneath. Sori inframedial; indusia thin, glabrous; sporangia lacking hairs near annulus.

Distribution: Fernando Po and S. Tomé.

Christensen regarded *A. elatum* Mett. as the correct basionym for this species, believing that *A. elatum* Bojer was a nomen nudum, but Bojer printed a brief description (see *Sphaerostephanos elatus* of present work).

10. *Pneumatopteris prismaticus* (Desv.) Holtt., comb. nov.—*Nephrodium prismaticum* Desv. in Mem. Soc. Linn. Paris **6**: 256 (1827).—*Dryopteris prismatica* C. Chr. in Dansk. Bot. Ark. **7**: 202 (1932).—*Cyclosorus prismaticus* Ching in Bull. Fan Mem. Inst. Biol. Bot. **10**: 248 (1941). Type: Mauritius, no collector cited (P !).

Aspidium caudiculatum Sieber ex Kunze, Linnaea **24**: 280 (1851).—*Nephrodium caudiculatum* Presl. Epim. Bot.: 46 (1851).—*Thelypteris caudiculata* Reed in Phytologia **17**: 266 (1968). Type: Mauritius, Sieber 47 (orig. lost; dupl. K !).

Rhizome short-creeping; stipe 20 cm long; 3–4 pairs reduced pinnae at base of frond, lower orbicular, upper elongate, not auricled; lowest large pinna much narrowed towards their bases which are not dilated. Largest pinnae 17 – $23 \times 2,2$ – $2,5$ cm, bases of middle pinnae sometimes dilated on basiscopie side, acuminate, lobed to a little more than half-way towards costa; lobes slightly oblique, slightly dentate; costules 4–5 mm apart; veins 6–8 pairs, one pair anastomosing, one pair to sides of membrane; lower surface glabrous. Sori medial; indusia glabrous; sporangia lacking glandular hairs.

Distribution: Mauritius, Réunion. This species is very close to *P. venulosa* but the pinnae are not so wide and are differently shaped at their bases.

11. *Pneumatopteris comorensis* Holtt., sp. nov.

Caudex verisimiliter erectus; stipes 30 cm longus usque pinnam reductam infimam, paleis adpressis vestitus; pinnae reductae 4-jugatae, infimae 1×1 cm, superiores usque $2 \times 1,5$ cm, crenatae, non auriculatae; pinnae infimae evolutae basin versus non angustatae; pinnae maximae $33 \times 3,0$ cm, basi truncatae, caudato-acuminatae (cauda $2\frac{1}{2}$ cm longa), dimidio vel paulo ultra

versus costam lobatae; lobi non falcati, integri, apice rotundati, ciliati; costula $4\frac{1}{2}$ –5 mm inter se distantes; venae usque 12-jugatae, $1-1\frac{1}{2}$ -jugatis anastomosantibus; rachis subtus sparsim hirsutae, costae copiose costulae sparsim pilis patentibus vestitae. Sori mediales; indusia tenuia, longe-pilosa; sporangia pilis capitatis elongatis ornata.

Type: COMRO ISLANDS, Johanna, 200–800 m, *Hildebrandt 1782* (holotype K; dupl. B, L, FI).

EXCLUDED SPECIES

Nephrodium lucidum Bak., Gard. Chron. N.S. **8**: 456 (1877).—*Dryopteris lucida* C. Chr. Ind. Fil.: 276 (1905); Dansk. Bot. Ark. **7**: 49, pl. 12, fig. 8, 9 (1932).—*Cyclosorus lucidus* Ching in Bull. Fan Mem. Inst. Biol. Bot. **10**: 246 (1941).—*Thelypteris lucida* Reed in Phytologia **17**: 290 (1968). Type: cult. Hort. Bot. Kew. (K !).

This cultivated plant from which this was described was stated to have been sent to Kew from Madagascar, but it is unlike any other specimens found in Madagascar, and closely resembles *Aspidium laeve* Mett., described from a specimen from the Philippines (*Dryopteris luzonica* Chr. is a later name for the same species). Labels of plants in cultivation are easily misplaced, and I think this must have happened in the present case.

14. *AMPHINEURON* Holttum.

Blumea **19**: 45 (1971)

Caudex erect to long-creeping; fronds bipinnatifid, basal pinnae not reduced or 1–2 rudimentary and remote basal pinnae sometimes present; basal veins either free or anastomosing (in *A. opulentum* both conditions commonly in same frond); small capitate hairs present on lower surfaces, often acicular hairs also, not sessile spherical glands (in some Malesian species larger resinous glands present); sori usually confined to lobes of lamina, indusiate or not; sporangia never bearing hairs or glands near annulus; hair on sporangium-stalk of several cells with spherical glandular end-cell; spores irregularly tuberculate; chromosome number 36.

12–15 species, not yet all clearly defined, mainly in Malesia; two widely distributed species occur in Africa and islands.

Caudex short, suberect; apex of frond not pinna-like; pinnae lobed more than $\frac{1}{2}$ way to costa; veins sometimes uniting, sometimes free 1. *A. opulentum*

Caudex long-creeping; apex of frond pinna-like; pinnae lobed less than $\frac{1}{2}$ way; basal veins always anastomosing 2. *A. terminans*.

1. *Amphineuron opulentum* (Kaulf.) Holtt. in *Blumea* **19**: 45 (1971).—*Aspidium opulentum* Kaulf., Enum. Fil. Chamisso: 238 (1824).—*Thelypteris opulenta* Fosberg in Smiths. Contr. Bot. **8**: 3 (1972), excl. syn. *Nephrodium terminans* Wall. Type: Guam, *Chamisso* (LE).

Nephrodium impressum Desv. in Mem. Soc. Linn. Paris **6**: 259 (1827).—*Dryopteris impressa* Posth. in Verh. K. Akad. Wetens. Amst. **36**, 5: 14 (1937); Backer & Posth., Varen—fl. Java: 57 (1939). Type: Timor (P).

Aspidium extensum Bl., Enum., Pl. Jav.: 156 (1828).—*Nephrodium extensum* Moore, Ind. Fil.: 91 (1858); Bedd., Handb. Ferns Br. India: 269 (1883).—*Dryopteris extensa* Kuntze. Rev. Gen. Pl. **2**: 812 (1891).—*Cyclosorus extensus* Ching in Bull. Fan Mem. Inst. Bio. Bot. **8**: 182 (1938); Holtt. Rev. Fl. Malaya **2**: 264, fig. 150 (1955).—*Thelypteris extensa* Morton, Amer. Fern Journ. **49**: 113 (1959); Schelpe, Fl. Zamb. Pterid.: 193 (1970). Type: Pulo Pinang, Blume (L).

Lastrea malaccensis Presl, Epim. Bot.: 35 (1851). Type: Malacca, Cuming 291 (PRC ! K !).

Nephrodium conionevron Fée, Gen. Fil.: 308 (1852). Ceylon, Gardner 51 (not found).

Nephrodium punctatum Parish ex Bedd., Ferns Br. India: t. 131 (1866). Type: Moulmein, Burma, Parish (K !).

Nephrodium parasiticum var. *multijugum* Clarke in Trans. Linn. Soc. II Bot. **1**: 533 (1880). Type of var.: Penang, Wallich 348 p.p. (K !).

Nephrodium wakefieldii Bak. in Ann. Bot. **5**: 326 (1891).—*Dryopteris wakefieldii* C. Chr., Ind. Fil.: 301 (1905). Type: Mombasa, Wakefield (K !).

Dryopteris sulfurea E. Brown in Bishop Mus. Bull. **89**: 23 (1931).—*Thelypteris sulfurea* Reed, Phytologia **17**: 318 (1968). Type: Marquesas, Brown 193 (BISH !).

Caudex short-creeping; stipe to 70 cm, lamina to 80 cm with 15–25 pairs of pinnae; rarely 1 reduced basal pinna present; lower pinnae narrowed towards their bases. Largest pinnae to 25 × 2.5 cm, acuminate, lobed about $\frac{2}{3}$ towards costa, lobes oblique, slightly falcate; costules 4 mm apart (fertile) to 5–6 mm (sterile); veins 8–10 pairs, basal pair passing to sides of sinus-membrane or writing below it with a short excurrent vein; lower surface of rachis and costae bearing short hairs, scattered longer hairs on costules, costules and veins covered with small yellow capitate hairs, smaller colourless capitate hairs and/or acicular hairs on surface between veins; costae hairy on upper surface, scattered hairs on costules and veins. Sori confined to lobes, supramedial, in slight depressions in the lamina; indusia with small yellow glands on edges.

Distribution: throughout tropical Asia and Malesia, N. Queensland, eastwards to Society Islands and Marquesas; Seychelles; Kenya, Mozambique, Tanzania. A plant from Singapore was shown to be tetraploid.

2. *Amphineuron terminans* (Hook.) Holtt., comb. nov.—*Nephrodium terminans* Hook., Spec. Fil. **4**: 73 (1862); Bedd., Ferns S. India: t. 90 (1863). Type: Kamoun, Wallich 386 (Herb. Hook. K !; no specimen in Herb. Wallich).

Nephrodium oreopteris Fée, Gen. Fil.: 306 (1852), non Desv. 1827. Type: Luzon, *Cuming* 48 (orig?; dupl. K !).

Thelypteris wagneri Fosb. & Sachet in Smiths. Contr. Bot. **8**: 6 (1972). Type: Java, *Raciborski* (US).

Aspidium pteroides sensu Sw in Schrad. J. Bot. 1800 (2): 33 (1801), fide Ching, not *Polypodium pteroides* Retz.

Nephrodium pteroides sensu J. Sm., Cat. Cult. Ferns: 54 (1857); Bak., Syn. Fil.: 289 (1868) p.p.; Bedd., Handb. Ferns Br. India: 269 (1883); Racib., Fl. Btzig **1**: 183 (1898); not *Polypodium pteroides* Retz.

Dryopteris pteroides sensu C. Chr., Ind. Fil.: 287 (1905) p.p.; van Ald. van Ros., Handb. Mal. Ferns: 209 (1908); not *Polypodium pteroides* Retz.

Nephrodium unitum sensu Hook. & Arn., Bot. Beechey Voy.: 256 (1838); sensu Hook. Gen. Fil.: t. 48B, fig. 6 (1840); not *Nephrodium unitum* R.Br.

Dryopteris interrupta sensu Ching in Lingn. Sci. Journ. **12**: 566 (1933).—*Cyclosorus interruptus* sensu Ching in Bull. Fan Mem. Inst. Biol. Bot. **8**: 184 (1938); Holtt. Rev. Fl. Malaya **2**: 262, fig. 149 (1955); not *Pteris interrupta* Willd.

Dryopteris obtusata sensu Ballard, in Kew Bull. 1932: **75**, not *Aspidium obtusatum* Sw.

Rhizome long-creeping, 5–8 mm diameter; stipe to 50 cm or more long, scales 8×1 mm, thin, hairy; lamina to 80 cm long, apex pinna-like, pinnae to 25 pairs, lowest pair \pm reduced. Largest pinnae commonly $17\text{--}20 \times 1.7\text{--}2.0$ cm (to 30×2 cm), base cuneate in lower pinnae, truncate in upper, lobed $\frac{1}{4}\text{--}\frac{1}{3}$ towards costa, lobes oblique, falcate, broadly pointed; costules 4–5 mm apart at 60° or less; veins 6–9 pairs, basal pair anastomosing, next pair to sides of sinus-membrane; lower surface throughout bearing very short erect hairs, capitate hairs abundant only on distal parts of veins, especially near apices of pinna-lobes; upper surface hairy on costae, scattered hairs on costules, veins and on surface near edge. Sori close to margins of pinna-lobes, not on basal veins; indusia large, glabrous or with short hairs.

Distribution: Ceylon and India; Burma to S. China; throughout Malesia to New Guinea; in Africa only known from one collection from Central African Republic and one from Fernando Po (K). Plants in Ceylon were found to be tetraploid.

15. *SPHAEROSTEPHANOS* J. Smith

Hook. Gen. Fil.: t. 24 (1839); Holtt., Blumea **19**: 29 (1971)

Caudex various, scales always narrow and hairy; fronds with varying number of much-reduced basal pinnae; aerophores often swollen, young fronds sometimes mucilaginous; veins usually anastomosing; lamina not pustular when dried; surfaces always \pm hairy, hairs on upper surface, where present, appressed

antrorse; sessile spherical glands variously present on both surfaces, indusia and sporangia, but sometimes replaced by short acicular hairs; on stalk of sporangium a hair of 3–4 cells, end cell swollen but not spherical; spores covered with many small wings.

More than 120 species; San Tomé, E. Africa, Madagascar and Mascarene Islands; southern India and Ceylon, Burma to S. China, throughout Malesia and the Pacific to Tahiti, with greatest number of species in New Guinea.

The generic name *Sphaerostephanos* was given to a species of Western Malesia which has elongate sori, but this character is not a sharply distinctive one. The name refers to the fringe of spherical glands on the indusia of the type species.

Caudex erect:

Pinnae less than 2 cm wide, crenate 1. *S. arbuscula*
Many spherical glands on upper surface; larger pinnae auricled at base

Few glands on upper surface; larger pinnae not auricled subsp. *arbuscula*
Pinnae to 2.5 cm wide, lobed half way to costa subsp. *africanus*

Caudex long-creeping:

Pinnae rarely over 1.5 cm wide, lobed less than half way to costa; glands present on lower surface and on sporangia 3. *S. unitus*

Pinnae to at least 2 cm wide, lobed half way to costa; no glands on surfaces; sporangia setose 4. *S. elatus*

Pinnae to 30 cm long; hairs on rachis and costae rather sparse, $\frac{1}{2}$ mm long; few hairs on indusia subsp. *elatus*

Pinnae to 15 cm long; dense very short hairs on rachis and costae with some longer ones; indusia densely short-hairy subsp. *thomensis*

1. ***Sphaerostephanos arbuscula* (Willd.) Holtt., comb. nov.**—*Aspidium arbuscula* Willd. in Linn. Sp. Pl. ed. IV, 5: 233 (1810).—*Nephrodium arbuscula* Desv. in Mem. Soc. Linn. Paris 6: 253 (1827); Beddome, Handb. Ferns Br. India: 276 (1833).—*Dryopteris arbuscula* Kuntze, Rev. Gen. Pl. 2: 812 (1891).—*Cyclosorus arbuscula* Ching in Bull. Fan Mem. Inst. Biol. Bot. 8: 194 (1938).—*Thelypteris arbuscula* K. Iwats. in Acta Phytotax. Geobot. 21: 170 (1965). Type: Mauritius, Herb. Willd. no. 19,763 (B !).

Nephrodium hookeri Houlst. & Moore in Gard. Mag. Bot. 3: 294 (1851). Type: cult. (BM).

Aspidium hookeri Wall. ex Hook. Ic. Pl. 10: t. 922 (1854), non Sweet 1830. Type: S. India, Dindigal, Herb. Wight Crypt. 116; Wall. Cat.: 64, no. 338 (K !).

Subsp. *arbuscula*. Caudex erect, to 30 cm or more tall; stipe 5–10 cm, densely short-appressed-hairy; lamina 40–60 cm or more long, 5–10 pairs lower pinnae gradually reduced, all auricled at acroscopic base. Largest pinnae 6–10 cm long, 7–12 mm wide above base, base distinctly auricled, acuminate to a rather blunt tip; edges crenate to a depth of 1–1½ mm; costules commonly 3–3½ mm apart, at c. 50° to costa; veins 4–6 pairs, 1½ pairs anastomosing, next to side of short sinus-membrane; lower surface of rachis and costae densely short-hairy, sparse hairs on costules and veins, spherical glands throughout;

glands also throughout upper surface. Sori medial; indusia glandular and short-hairy; yellow glands on sporangia.

Distribution: Mauritius, Réunion, Madagascar, Ceylon, S. India. Some specimens from Madagascar have pinnae very slightly crenate.

Subsp. *africanus* Holtt., subsp. nov. a subspecie arbuscula differt: pinnis majoribus (usque $16 \times 1,7$ cm) basi utroque latere leviter dilatatis, acroscopice non auriculatis, glandulis supra paucis. Type: Kenya, Kwale Distr., Shimba Hills, 300 m, *Drummond & Hemsley 1203* (K).

Distribution: Tanzania (N. Uluguru Mts, E. Usambara Mts), Kenya.

2. ***Sphaerostephanos subtruncatus*** (Bory) Holtt. in Kew Bull. **26**: 80 (1971).—*Polypodium subtruncatum* Bory in Bél. Voy. Ind. Or., Bot. **2**: 32 (1833). Type: India, Madeira, Mts de Dendigall, *Bélanger* (P !).

Dryopteris mauritiana var. *gardinieri* C. Chr. in Trans. Linn. Soc. II Bot. **7**: 413 (1912). Type: Seychelles, *J. S. Gardiner* (K !).

Mesochlaena polycarpa sensu Blatter & d'Almeida, Ferns of Bombay: 124, fig. 41 (1912), non (Bl.) Bedd.

Caudex erect; base of stipe to first reduced pinna 10 cm, to first large pinna 65 cm; reduced pinnae to 15 pairs, smallest 5 mm long, largest $3\frac{1}{2} \times 2$ cm, base truncate and somewhat auricled on acroscopic side; lamina to 120 cm long excluding reduced pinnae, pinnae 35 pairs. Largest pinnae $12 \times 2,5$ cm, widest at truncate base, acuminate, lobed about $\frac{1}{2}$ way to costa, lobes oblong, hardly falcate, tips rounded; costules 4 mm apart; veins to 10 pairs, $1\frac{1}{2}$ pairs anastomosing, $\frac{1}{2}$ –1 pair to sides of membrane; sessile spherical glands present throughout lower surface, copious short hairs on rachis and costae, few on costules and veins; upper surface of costae hairy, few hairs on costules and veins, not between veins, no glands. Sori medial, slightly elongate along veins; indusium large, glabrous or with a few short hairs; sporangia bearing yellow glands.

Distribution: S. W. India, Seychelles. The above description is based on Seychelles specimens. Plants from India show considerable variation in size of fronds; Beddome collected one with pinnae to $27 \times 2,4$ cm (he labelled it *Nephrodium truncatum* var. ?) but others are much smaller.

3. ***Sphaerostephanos unitus*** (Linn.) Holtt., comb. nov.—*Polypodium unitum* Linn., Syst. Nat. ed X, **2**: 1326 (1759) excl. syn.—*Aspidium unitum* Sw. in Schrad. Journ. Bot. 1800 (2): 32 (1801), *nomen tantum*.—*Nephrodium unitum* R. Br., Prodr. Fl. N. Holl.: 148 (1810), *nomen tantum*.—*Polystichum unitum* Gaud. in Freyc. Voy. Bot.: 325 (1827) excl. syn.—*Aspidium propinquum* R. Br. and *Tectaria serrata* Cav.—*Dryopteris unita* Kuntze, Rev. Gen. Pl. **2**: 811 (1891).—*Cyclosorus unitus* Ching in Bull. Fan Mem. Inst. Biol. Bot. **8**: 192 (1938).—*Thelypteris unita* Morton in Amer. Fern Journ. **49**: 113 (195). Type: without locality, in Herb. Linn. (!).

Nephrodium insculptum Desv. in Mem. Soc. Linn. Paris **6**: 254 (1827). Type: Réunion, no collector named (P!).

Aspidium cucullatum Bl., Enum. Pl. Jav.: 151 (1828).—*Nephrodium cucullatum* Bak., Syn. Fil.: 290 (1867); Bedd. Handb. Ferns Br. India: 270 (1883). Type: Java, Blume (L).

Nephrodium haenkeanum Presl, Epim. Bot: 46 (1851); Holtt. in Novit. Bot. Inst. Bot. Univ. Carol. Prag. 1968: 17 (1969).—*Aspidium haenkeanum* Journ. in Ann. Sci. Nat. Ser. V, **18**: 298 (1873).—*Dryopteris haenkeana* Kuntze, Rev. Gen. Pl. **2**: 812 (1891).—*Cyclosorus haenkeanus* Ching in Bull. Fan Mem. Inst. Biol: Bot. 194 (1938).—*Thelypteris haenkeana* Reed in Phytologia **17**: 281 (1968). Type: Philippines, Haenke (PRC!).

Aspidium unitum Sieber ex Mett., Farnagatt. IV: 107 (1858).—*Nephrodium unitum* Hook., Spec. Fil. **4**: 81 (1862). Type: Mauritius, Sieber 43 (B?; K!).

Nephrodium leuconeuron Fée, Gen. Fil.: 306, t. 18C, fig. 3 (1852).—*Aspidium leuconeuron* Kuhn, Fil. Afr.: 136 (1868).—*Dryopteris leuconeura* Nakai in Bot. Mag. Tokyo **47**: 180 (1933).—*Thelypteris leuconeura* Schelpe in Journ. S. Afr. Bot. **31**: 266 (1965) excl. syn. *Nephrodium mauritianum* Fée. Type: Réunion, Olivier (not seen).

Other names of Fée which are possible synonyms are: *N. microcarpum* Fée op. cit. 307; *N. plectochlaena* Fée, op. cit. 307; both types from Réunion, not seen.

Caudex long-creeping, 5 mm diameter or more; stipe 10–20 cm to lowest reduced pinna; reduced pinnae 6 or more pairs, lowest very small, upper ones triangular with wide base, widest on acroscopic side, transition to large pinnae abrupt; lamina 30–60 cm or more, excluding reduced pinnae, texture firm. Largest pinnae commonly 10–15 × 0.9–1.3 cm (sometimes to 20 × 2 cm), base broadly cuneate, apex evenly attenuate, lobed about $\frac{1}{3}$ towards costa, lobes rounded and slightly pointed; costules commonly 3–3½ mm apart, at wide angle to costa; veins 8–10(–14) pairs, 1½ pairs anastomosing, next 2–4 pairs to sides of sinus-membrane; lower surface of rachis and costae copiously hairy, costules and veins with shorter hairs, also small yellow glands; upper surface only hairy on costae. Sori supramedial; indusia firm, usually with short hairs; sporangia bearing yellow glands.

Distribution: Tanzania; Madagascar, Mauritius, Réunion, Rodriguez, Seychelles; Ceylon & S. India; Assam & Burma to Tonkin; throughout Malesia; in Pacific to Marianas, Tonga, Fiji and New Caledonia.

Nephrodium haenkeanum Presl was based on a specimen with broad pinnae, but otherwise typical. Specimens in S. India and Ceylon have larger glands on the lower surface than in Malesia; the Linnean type resembles S. India specimens. The literature references cited by Linnaeus certainly refer to specimens of *Cyclosorus* (s. str. of the present work), but his specimen is regarded as fixing

the name. During the 19th century the name was interpreted in both ways, with consequent confusion. Some 19th century authors also did not learn how to distinguish the present species from *Aspidium aridum* Don; the latter is a species of *Christella* and has elongate glands on the lower surface. Published distribution records are thus often unreliable.

4. **Sphaerostephanos elatus** (Bojer) Holtt., comb. nov.—*Aspidium elatum* Bojer, Hort. Maurit.: 390 (1837).—*Nephrodium elatum* Bak., Syn. Fil. ed. 2: 502 (1874), non Bak. 1867; Bak. in Fl. Maurit. & Seych.: 498 (1877). Type: Mauritius, Bojer (W).

Aspidium maximum Bojer ex Bak., Syn. Fil. ed. 2: 502 (1874). Type: Mauritius, Bojer (K !).

Nephrodium mauritianum Fée, Gen. Fil.: 308 (1852), non Desv. 1827.—*Aspidium mauritianum* Kuhn, Fil. Afr.: 136 (1868), non Desv. 1827.—*Nephrodium elatum* var. *mauritianum* Bak., Fl. Maurit. & Seych.: 499 (1877).—*Dryopteris mauritiana* C. Chr., Ind. Fil.: 277 (1905), nom. nov.; Trans. Linn. Soc. II Bot., 7: 413 (1912); Dansk. Bot. Ark. 7: 51 (1932).—*Cyclosorus mauritianus* Ching in Bull. Fan Mem. Inst. Biol. 10: 246 (1941).—*Thelypteris mauritiana* Reed in Phytologia 17: 291 (1968). Type: Mauritius, de Montbrison (not seen).

Nephrodium procerum Bak., Syn. Fil. ed. 2: 502 (1874), non Don 1825. Type: Mauritius, Bojer (K !).

Subsp. *elatus*. Caudex long-creeping, to 1 cm diameter; at base of frond c. 6 pairs of strongly trilobed much-reduced pinnae, lowest large pinna narrowed to base on basiscopic side, not auricled. Largest pinnae 20–35 × 2.0–3.5 cm; base broadly cuneate, not auricled; apex acuminate and serrate; lobed half-way to costa; lobes strongly falcate, narrowed slightly towards an abruptly broad-pointed apex; costules 5–6 mm apart; veins 14 to 18 pairs, basal 1½ pairs anastomosing, next 1–1½ pairs to sides of long membrane; lower surface with rather sparse spreading hairs on rachis, costae and costules, erect hairs between veins; longer antrorse hairs on upper surface of costae and similar hairs sparsely on costules and veins, a variable number of short hairs between veins (most on sterile pinnae). Sori inframedial; indusia large with a few hairs; sporangia bearing short setae.

Distribution: Mauritius, Réunion, Rodriguez. The type of *A. maximum* has pinnae 35 × 3.2 cm, with 18 pairs of veins; that of *N. procerum* Bak. has pinnae 21 × 2.0 cm; a specimen of a young plant from Réunion, already fertile, is still smaller, with a reduced number of small basal pinnae.

Subsp. *thomensis* Holtt, subsp. nov. a subsp. *elato* differt: pinnis usque 15 × 2.0 cm, costulis 4 mm inter se distantibus, venis 10-jugatis; rachide, costis infimis, indusiisque, pilis minutis erectis densis vestitis. Type: San Tomé, *A. Moller s.n.* 1885 (P).

NEW SPECIES DESCRIBED

Parathelypteris salazica (from Reunion); *Pseudocyclosorus camerounensis*, *P. johannae*; *Christella altissima* (Natal), *C. modesta* (Madagascar); *Pneumatopteris humbertii* (Madagascar), *P. usambarensis* (Tanzania), *P. comorensis*.

NEW COMBINATIONS. *Metathelypteris fragilis* (Bak.) Holtt.; *Amauropelta membranifera* (C. Chr.) Holtt., *A. heteroptera* (Desv.) Holtt., *A. bergiana* (Schlechtend.) Holtt. (with new varieties *calva* and *tristanensis*), *A. strigosa* (Willd.) Holtt., *A. tomentosa* (Thouars) Holtt., *A. oppositifolia* (C. Chr.) Holtt.; *Pseudocyclosorus pulcher* (Bory ex Willd.) Holtt.; *Christella distans* (Hook.) Holtt., *C. hilsenbergii* (Presl) Holtt., *C. dentata* (Forsk.) Holtt., *C. guineensis* (Chr.) Holtt., *C. friesii* (Brause) Holtt., *C. multifrons* (C. Chr.) Holtt., *C. afzelii* (C. Chr.) Holtt., *C. callensii* (Alston) Holtt., *C. microbasis* (Bak.) Holtt., *C. gueinziana* (Mett.) Holtt., *C. chaseana* (Schelpe) Holtt.; *Pneumatopteris unita* (Kunze) Holtt., *P. blastophora* (Alston) Holtt., *P. subpennigera* (C. Chr.) Holtt., *P. oppositifolia* (Hook.) Holtt., *P. afra* (Chr.) Holtt., *P. remotipinna* (Bonap.) Holtt., *P. venulosa* (Kuntze) Holtt., *P. prismatica* (Desv.) Holtt.; *Amphineuron terminans* (Hook.) Holtt.; *Sphaerostephanos arbuscula* (Willd.) Holtt., *S. unitus* (Linn.) Holtt., *S. elatus* (Bojer) Holtt. (with subsp. *thomensis*).

HETEROSTYLY IN SOUTH AFRICAN FLOWERING PLANTS: A CONSPECTUS

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ABSTRACT

Heterostyly or related phenomena have been reported in 19 families of flowering plants represented in South Africa. Published studies of this phenomenon are reviewed and it is suggested that the reports of distyly for Capparaceae, Commelinaceae, and Santalaceae are

ERRATA

Vol. 40 (1): 27-45. Discriminant analysis used to detect population variation amongst grasses collected on mine dumps, by F. M. Thatcher and R. A. Lubke.

Page 33

Table 1 for "Length of palea awn" read "Length of lemma awn of second floret".

Page 43

Figure 11 for "Length of palea awn" read "Length of lemma awn of second floret"

and

for "Length of lemma awn" read "Length of lemma awn of first floret".

In sommige gevalle is die verskille moontlik 'n gevolg van vegetatiewe voortplanting in plaas van geslagtelike voortplanting. Die monomorfeise *Nivenia* (Iridaceae) soorte word saamgestel uit self-vereenigbare lang styl plante wat moontlik ontwikkel het uit dimorfeise, self-vereenigbare soorte. Dieselfde verwantskap bestaan moontlik by *Lithospermum* (Boraginaceae). Ongevoel word voorkoms van distilie word aangeteken vir *Jasminum* (Oleaceae) en *Sebaea* (Gentianaceae). Vroëre verslae oor 'n aantal families word bevestig en aangevul. Die besondere en enige links-en-regh-draaiende blomme van verskeie Haemodoraceae en Tecophilaeaceae word beskryf en bespreek. Heterostilie kom volop in die Suid-Afrikaanse flora voor maar dit is duidelik dat baie min oor die voortplantingsisteme van enige heterostilie angiosperme bekend is.

INTRODUCTION

Heterostyly has been reported in approximately 24 families of flowering plants of diverse phyletic positions (Vuilleumier, 1967). The term refers to

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ABSTRACT

Heterostyly or related phenomena have been reported in 19 families of flowering plants represented in South Africa. Published studies of this phenomenon are reviewed and it is suggested that the reports of distyly for Capparaceae, Commelinaceae, and Santalaceae are based on misinterpretations of floral structure. Although all native species of *Oxalis* (Oxalidaceae) in South Africa are structurally tristylous, some of these are self-compatible and at least one species is autogamous. Pollen heteromorphism exists in the species of *Oxalis* examined although it does not always follow expected patterns. Most populations of *Oxalis* sampled deviate from equality of representation of the three forms. In some instances this inequality is probably a result of vegetative propagation rather than sexual reproduction. The monomorphic species of *Nivenia* (Iridaceae) are composed of self-compatible long-styled plants that are likely derived from the dimorphic, self-compatible species. The same relationship probably also exists in *Lithospermum* (Boraginaceae). Unusual expressions of distyly are recorded in *Jasminum* (Oleaceae) and *Sebaea* (Gentianaceae). Earlier reports for a number of families are confirmed or amplified. The unique and enigmatic left- and right-handed flowers of various Haemodoraceae and Tecophilaeaceae are described and discussed. Heterostyly is richly represented in the South African flora, but it is evident that little is known about the reproductive systems of any heterostylous South African angiosperm.

UITTREKSEL

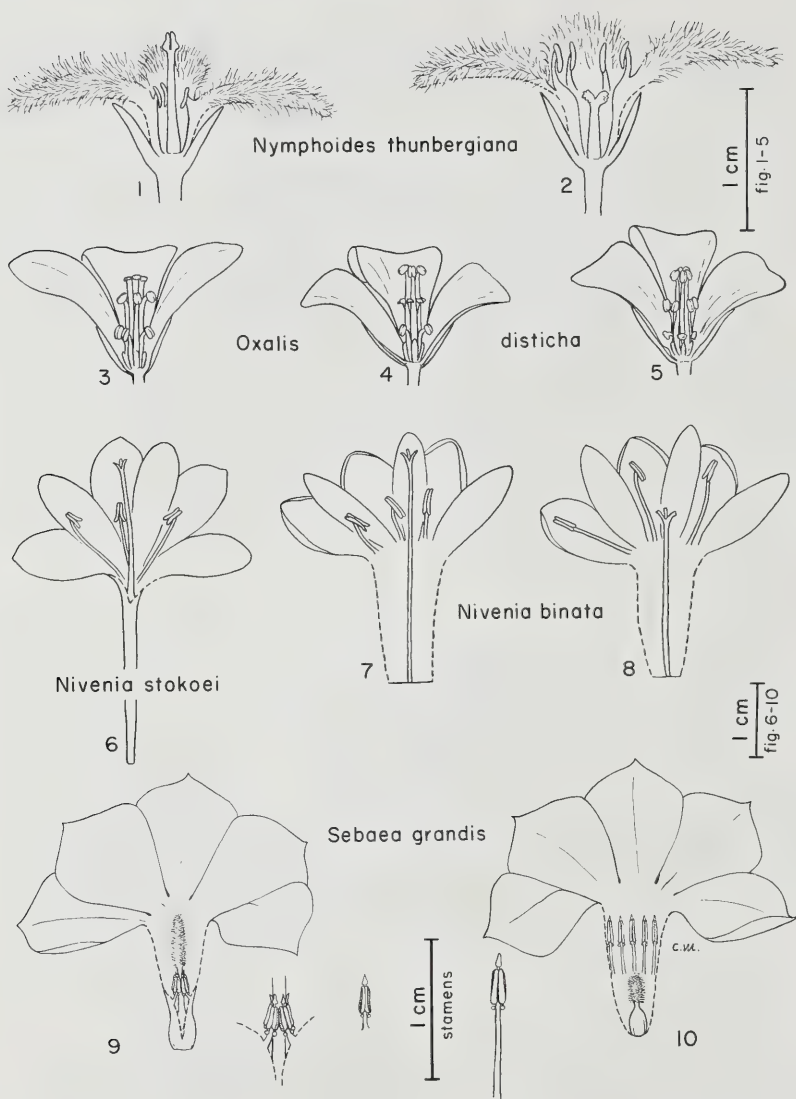
HETEROSTILIE BY SUID-AFRIKAANSE BLOMPLANTE

Heterostilie of verwante verskynsels is by 19 families blomplante wat in Suid-Afrika verteenwoordig is, gevind. Gepubliseerde ondersoeke van die verskynsel word in oënskoue geneem en dit word aan die hand gedoen dat die verslae oor distilie by Capparaceae, Commelinaceae en Santalaceae op 'n foutiewe vertolking van die blom bou berus. Alhoewel alle inheemse *Oxalis* (Oxalidaceae) soorte in Suid-Afrika in bou tristilies is, sommige tog self-vereënisbaar en ten minste een soort autogaam is. Stuifmeel heteromorfisme bestaan in die soorte van *Oxalis* wat ondersoek is, alhoewel dit nie altyd die verwagte patrone volg nie. Meeste *Oxalis* bevolkings getoets wyk af van die gelykheid van voorstelling van die drie vorms. In sommige gevalle is die verskille moontlik 'n gevolg van vegetatiewe voortplanting meer as geslagtelike voortplanting. Die monomorfe *Nivenia* (Iridaceae) soorte word saamgestel uit self-vereënisbare lang styl plante wat moontlik ontwikkel het uit dimorfe, self-vereënisbare soorte. Dieselfde verwantskap bestaan moontlik by *Lithospermum* (Boraginaceae). Ongewone voorkoms van distilie word aangeteken vir *Jasminum* (Oleaceae) en *Sebaea* (Gentianaceae). Vroeë verslae oor 'n aantal families word bevestig en aangevul. Die besondere en enige links-en-regh-draaiende blomme van verskeie Haemodoraceae en Tecophilaeaceae word beskryf en bespreek. Heterostilie kom volop in die Suid-Afrikaanse flora voor maar dit is duidelik dat baie min oor die voortplantingsisteme van enige heterostilie angiosperme bekend is.

INTRODUCTION

Heterostyly has been reported in approximately 24 families of flowering plants of diverse phyletic positions (Vuilleumier, 1967). The term refers to

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dimorphism or trimorphism in floral features that includes differences in length of styles; position of stamens; size of stigmas and stigmatic papillae; size, sculpturing, colour, and contents of pollen grains; physiological reaction of pollen and carpellary tissue; and an array of other morphological and physiological features of flowers. In the expression termed distyly, some plants of a species bear flowers with long styles and short stamens; others have flowers with short styles and long stamens (e.g., Fig. 1, 2). This floral dimorphism is generally accompanied by a variable number of the other differences between the two floral forms that are listed above. In tristily, three types of plants occur: those having long-styled flowers with two sets of anthers below the level of the stigma; those having mid-styled flowers with one set of anthers borne above the stigma and a second set below; and those having short-styled flowers with two sets of anthers above the stigma (e.g., Fig. 3-5). As in distyly, there are generally other morphological features that distinguish the flowers of each of the three forms of a tristylous species. Tristyly is rare and occurs only in Lythraceae, Pontederiaceae, and Oxalidaceae.

Although heterostyly has been known as a morphological feature of various flowering plants for several centuries, it was not until the middle of the 19th century that Darwin in Britain and Hildebrand in Germany began to understand the biological significance of this floral heteromorphism. Contemporaneously, both men demonstrated that heterostyly is generally associated with an incompatibility system which allows only certain fertilizations to take place. These workers believed that the positional relationships of anthers and stigmas enhance pollen transfer between anthers and stigmas at equivalent positions. Thus, heterostyly came to be viewed as a morphological-physiological mechanism that promotes outcrossing, though in fact there are still only a few empirical observations of field populations which explore this supposition.

Heterostyly has been reported or suggested to occur in a number of genera belonging to nearly twenty families of flowering plants represented in South Africa. With a few exceptions, the floral morphology and reproductive systems of these taxa have not been investigated. During eight months in 1970 and 1971 I studied a number of these plants in the field and subsequently in cultivation, examined herbarium specimens in South Africa and Britain, and conducted a survey of the relevant literature. The purpose of this paper is to

FIG. 1-10.

Heterostyly in representative South African plants.

Fig. 1-2, Long- and short-styled flowers of *Nymphoides thunbergiana* (Tim s.n.). Fig. 3-5, Long-, mid-, and short-styled flowers of *Oxalis disticha* (Ornduff 7297). Fig. 6, Flower of the monomorphic *Nivenia stokoei* (Goldblatt s.n.). Fig. 7-8, Long- and short-styled flowers of *Nivenia binata* (Ornduff 7570). Fig. 9-10, Long- and short-styled flowers of *Sebuca grandis* (Hilliard & Buritt, s.n.) with details of the stamens of each form.

summarize what is known of heterostyly in South African plants based on studies published by others, to present a number of original observations, and to suggest areas for future research in this interesting phenomenon which is so richly developed in the flora of the Republic.

BORAGINACEAE

There are reports of distyly for a South American species of *Cordia* (Darwin, 1877) but material of the South African species in the Compton Herbarium was inadequate for verification of this trait. My observations on the introduced South American annual weed *Amsinckia hispida* (Ruiz & Pavon) Jtn. indicate that it is homostylous and self-pollinating, although some of the North American species in this genus are distylous (Ray and Chisaki, 1957). The four species of *Lithospermum* in South Africa are monomorphic (Johnston, 1952) though apparently not homostylous, thus paralleling in some respects the condition noted below for *Nivenia* (Iridaceae). Although distyly is known to occur in *Anchusa*, I have been unable to find a report for the South African species.

CAESALPINACEAE

Vogel (1955) has stated that *Bauhinia esculenta* Benth. (= *B. burkeana* Burch.) is distylous in South Africa, although neither Urban (1883) nor subsequent workers have remarked on this trait. Vogel indicates that both the long-styled and the short-styled form produce seed, thus ruling out the possibility of dioecism. However, the pollen is said to be monomorphic, although no measurements are given (Vogel, 1955). The occurrence of distyly in *Bauhinia* is a unique occurrence of this trait in the legumes sensu lato (Vuilleumier, 1967) and a fuller documentation of the morphological expression of distyly and the associated breeding systems of the South African species of this genus is warranted. Vogel also states that the related *B. fassoglensis* Kotschy is monomorphic, though the flowers of the population he visited were all long-styled. However, on the basis of a floral description given by Urban, short-styled plants of this species may also exist. As in *Nivenia*, the occurrence of monomorphic but not homostylous populations of *B. fassoglensis* suggests that in *Bauhinia* heterostyly is not accompanied by self-incompatibility.

CAPPARACEAE

Vogel (1955) reported distyly and dioecy in the widespread *Cleome angustifolia* Forssk. (as *C. diandra* Burch.). Heterostyly is otherwise unknown in the family (Vuilleumier, 1967). Codd and Kers (1970) point out that perfect, male-sterile, and female-sterile flowers may occur intermittently along the racemes of this species and that "some specimens have flowers which approach female sterility by having normal stamens but much impoverished pistils". It is this

condition which these workers believe misled Vogel into considering the species to be heterostylous. Thus the Capparaceae can probably be removed from the list of families in which heterostyly occurs.

COMMELINACEAE

Vogel (1955) states that *Aneilema aequinoctiale* (Beauv.) Knuth is distylous although Morton (1966) makes no mention of this trait. Vogel's brief discussion of this species does not make it clear whether it is distylous or merely androdioecious. Van Druten (1959) mentions that "a large number of the flowers are sterile, having an undeveloped ovary and short or absent style". In view of the uncertainties concerning the floral morphology of *A. aequinoctiale* and the very brief attention devoted to this species by Vogel, it clearly merits additional investigation. It seems doubtful if the species is heterostylous.

CONNARACEAE

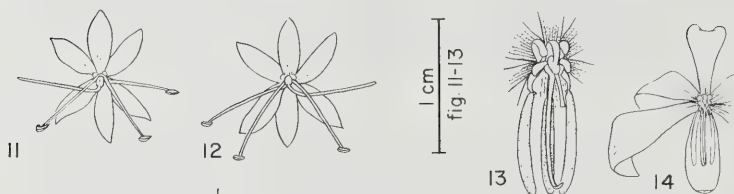
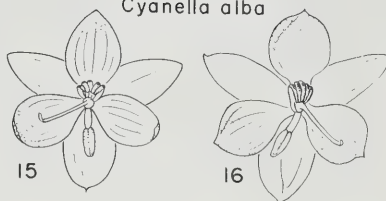
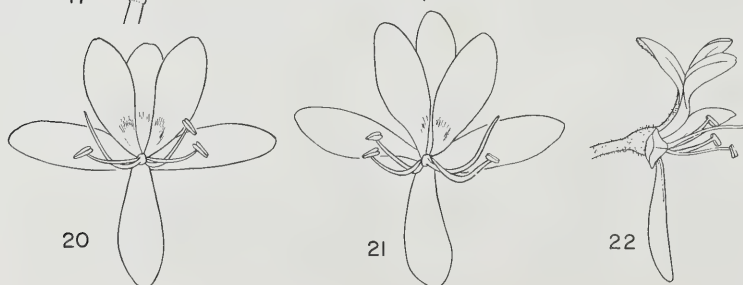
Cnestis natalensis (Hochst. ex Krauss) Planch. & Sond. is distylous (Mendes, 1966) but there are no reports concerning its breeding system.

ERYTHROXYLACEAE

Distyly and dioecism are widespread in the genus *Erythroxylum* (cf. Vuilleumier, 1967). Robson (1963) reported that *E. emarginatum* Thonn. and *E. delagoense* Schinz are dimorphic. My observations on herbarium specimens of *E. brownianum* Burt-Davy indicate that this species is also distylous.

GENTIANACEAE

Distyly has been reported for the African genus *Sebaea* (= *Exochaenium* = *Belmontia*; Gilg, 1895). The peculiar distyly of the southern African *S. grandis* (E. Mey.) Steudel was illustrated by Hill (1908) and further elaborated by Vogel (1955). In this species, the stigmatic papillae of the short-styled form are larger than those of the long-styled form, a condition contrary to that usually encountered in distylous species. Measurements of 20 pollen grains each from 2 long- and 2 short-styled plants of this species collected in the eastern Transvaal by Mrs. L. E. Davidson indicate an average pollen size of 15.4μ for long-styled flowers and 16.7μ for short-styled flowers, a difference that is significant on the basis of a *t*-test. Hill (1908) also mentions that the anthers of long-styled flowers are concrescent and extrorse, whereas in the short-styled flowers they are free and introrse. Pole Evans (1929) further states that the stamens in long-styled flowers have almost sessile anthers, while anthers of short-styled flowers have filaments. My own studies confirm these observations (Fig. 9, 10). Goldblatt (pers. comm.) reported that in the small population he

Barberetta aurea*Cyanella lutea**Cyanella alba**Wachendorfia brachyandra**Wachendorfia paniculata*

sampled in the Transvaal highlands there were 15 long- and 9 short-styled plants present.

Marais and Verdoorn (1963) also describe "medium" styled flowers; this, plus the description of *Exochaenium grande* var. *homostylum* Hill (1908), suggests the possibility that some sort of homostyly also occurs in this species, although, as pointed out by Marloth (1909) for *Sebaea exacoides* (L.) Schinz, the style of that species lengthens during the flowering process. Marloth further remarked that each flower of this species possesses "two distinct stigmatic organs, viz. a bilobed normal stigma and a lower one about the middle of the style. It has not yet been decided whether both kinds are always functionally perfect, for they may represent a veiled state of heteromorphism, viz. in some individuals of a species the upper stigma and in others the lower one may be receptive . . ." Clearly, *Sebaea grandis* and its congeners merit further study.

HAEMODORACEAE

Wilson (1887) reported a curious condition in *Wachendorfia*, in which the style of the flowers of some plants is deflected to the left and in others to the right. This is accompanied by differences in the position of the 3 stamens of the flower; in flowers with "left-handed" styles the third stamen is deflected along with the style and the remaining two stamens are deflected to the right. A reverse situation exists in "right-handed" flowers (Fig. 20-22). Wilson suggested that this condition represents a mechanism associated with promoting cross-pollination between the two forms. His sparse data suggest that the plants he worked with are moderately self-incompatible and that the highest seed set was obtained when crosses were made between the two floral forms.

Field studies of the 5 currently recognized species of *Wachendorfia* (Barker, 1950) indicate that all of them are dimorphic. In the large-flowered *W. paniculata* Burm. in which the perianth segments are spreading, ratios of "left" and "right" in natural populations are 1:1 (Table 1), suggesting that these large-flowered species are largely outcrossed. However, in the small-flowered *W. brachyandra* Barker, the short stamens and style are somewhat erect with the anthers and stigma in close proximity (Fig. 18, 19). This observation, plus the fact that populations of this species deviate from a 1:1 ratio (Table 1) suggest that

FIG. 11-22.

Floral morphology of representative South African Haemodoraceae and Tecophilaeaceae.

Fig. 11-12, "Left-" and "right-handed" flowers of *Barberetta aurea* (Hilliard & Burt 3476). Fig. 13-14, Details of stamens, styles, and flower of *Cyanella orchidiformis* (Ornduff 7187). Fig. 15-16, "Left-" and "right-handed" flowers of *Cyanella alba* (Ornduff 7424). Fig. 17, Portion of inflorescence of *Cyanella lutea* (Ornduff 7355) showing "left-" and "right-handed" flowers. Fig. 18-19, "Left-handed" flower of *Wachendorfia brachyandra* (Ornduff 7542). Fig. 20-22, "Left-" and "right-handed" flowers of *Wachendorfia paniculata* (Ornduff 7162) with lateral view of latter.

TABLE 1.

Numbers of plants with "left-handed" and "right-handed" flowers in populations *Wachendorfia*. Equality decision based on the Z test.

Locality (Cape Prov.)	Left-handed	Right-handed	1:1
(<i>W. paniculata</i> Burm.):			
RO 7308; Mamre	44	47	yes
RO 7328; Bokbaai	44	40	yes
RO 7343; Between Goudini and Breërivier . . .	27	34	yes
RO 7354; Worcester	55	60	yes
(<i>W. brachyandra</i> Barker):			
RO 7542; Kirstenbosch	49	11	no

W. brachyandra carries on some degree of autogamy. Studies of the pollen indicate that there is no consistent size heteromorphism associated with the floral dimorphism in the genus.

A rare relative of *Wachendorfia* is *Barberetta aurea* Harv., which is known from only a few localities in the Transkei and Natal. My observations of *Barberetta* in the field indicate that its floral dimorphism is similar to that of *Wachendorfia*, though some populations seemingly are monomorphic through vegetative propagation from an initial colonizer. The deflection of the style of *Barberetta* was noted by Geerinck (1971) although he apparently failed to realize that the species is dimorphic in the direction of this deflection (Fig. 11, 12). Whether or not this floral dimorphism is associated with an outbreeding system is unknown.

Another genus in the Haemodoraceae is the small genus *Dilatris*, which consists of 5 species restricted to the southwestern Cape Province, South Africa (Barker, 1940). Despite certain morphological differences between *Dilatris* and *Wachendorfia*, recent systematists consider that these two genera are rather closely related (de Vos, 1956). It is interesting to note that although the styles of *Dilatris* flowers are deflected in a fashion similar to those of *Wachendorfia*, both "left-" and "right-handed" flowers occur in the same inflorescence. Field studies of *D. corymbosa* Berg. indicate that approximately equal numbers of "left-" and "right-handed" flowers are open on a single plant at one time. The relationship of this condition to a breeding system is perplexing and merits further study.

Cyanella has sometimes been included in the Haemodoraceae (Barker, 1950) as well as other monocot families, but recent evidence suggests that the genus is a member of the Tecophilaeaceae (Hutchinson, 1944; de Vos, 1961; Geerinck, 1969). Despite its seemingly distant relationship to the Haemodoraceae, some species of *Cyanella*, such as *C. alba* L. f. and *C. lutea* L. f., show the same floral structure as *Dilatris* with respect to style and stamen deflection in the flowers of one plant (Fig. 15-17). However, other species of *Cyanella*, such as *C. capensis* L. and *C. orchidiformis* Jacq. have straight styles and stamens (Fig. 13, 14). It is

difficult to believe that the similarities between the floral structure of *Cyanella* and *Dilatis* are a result of parallel evolution; they suggest that these genera are more closely related than their placement in separate families would indicate.

In *Cyanella* and *Dilatis* of the Haemodoraceae (see above) it is difficult to see the adaptive value of "left-handed" and "right-handed" flowers in the same inflorescence. For field biologists interested in reproductive biology, both genera present intriguing and as yet unsolved problems.

IRIDACEAE

Distyly has been reported for two South African genera of Iridaceae. Adamson (1931) reported distyly for two species of *Nivenia*. Later, Brown (1933), Lewis (1934), and Weimarck (1940) observed the trait in various species of this relict woody genus of the southwestern Cape Province. At least three species—*N. dispar* N. E. Brown, *N. corymbosa* (Ker) Baker, and *N. binata* Klatt are definitely distylous (Fig. 7, 8). Mulcahy (1965) reported dimorphism in pollen size and wall patterns for the latter species. Other species, such as *N. capitata* (Klatt) H. Weimarck, *N. stokoei* (Guthrie) N. E. Brown, and *N. levynsiae* H. Weimarck are monomorphic (Fig. 6). The condition of still other species is uncertain; herbarium specimens are inadequate for a comprehensive confirmation of floral morphology and the literature for these is unclear on the point.

There is some indication that the heterostyly of *Nivenia* is different in some important respects from that which occurs in other plant families. A population sample of 54 plants of *N. binata* (Ornduff 7570, Swartberg Pass) indicated that long-styled plants outnumber short-styled ones in a ratio exceeding 2:1, suggesting either that the genetic basis of distyly in this species is not of the simple diallelic type that occurs in other families; or that the species is not self-incompatible and is incompletely outcrossing; or that the short-styled form has a lower viability than the long-styled form. The monomorphic species of *Nivenia* that I have investigated are not homostylous, but resemble the long-styled form of distylous species (Fig. 6). This observation led to the hypothesis that the dimorphic species are self-compatible, a conclusion consistent with the second explanation for the aberrant population composition noted above in the dimorphic species, and that monomorphism has developed by loss of the *S* (short-styled) allele from the dimorphic species rather than by the development of homostyly. This assumes that the genetic basis of distyly in *Nivenia* is the usual diallelic, single locus system in which *ss* is the genotype of the long-styled form and *Ss* is the genotype of the short-styled form. Selfing of a single long-styled plant of *N. corymbosa* (Ornduff 7666, Bains Kloof) indicated this plant to be self-compatible; likewise, the high seed production of isolated plants of the fully monomorphic *N. stokoei* indicates that this species, too, is self-compatible. The occurrence of self-compatible monomorphism without homo-

style in species of a genus in which distyly also occurs is perhaps unique among the 24-odd angiosperm families in which heterostyly is known to occur. Clearly, *Nivenia* deserves further experimental investigation.

A second genus of Iridaceae in which heterostyly has been reported is *Geissorhiza* (Bolus, 1930; Lewis, 1954). Bolus' description of the flowers of *G. heterostyla* L. Bolus suggests that it is trimorphic. My observations of a population cultivated at Kirstenbosch (originally from the Nieuwoudtville area) indicate that the species is dimorphic with respect to style length, though the position and length of the stamens are variable. In a sample of 30 plants from this population the length of style fell into two classes. One class consisted of 16 plants with styles 5,5 mm long or longer ($\bar{x} = 8,4$; range: 5,5–9,0) and a second class consisted of 14 plants with styles under 5,5 mm long ($\bar{x} = 3,8$; range: 2,5–5,0). The majority of flowers in the latter category had styles less than 4,0 mm long.

In its floral morphology, *Geissorhiza heterostyla* is reminiscent of various *Narcissus* species (Fernandes, 1964–65; Dulberger, 1964), though in these species the style-length differences are unassociated with incompatibility groupings. The possible relationship of the styler dimorphism of *G. heterostyla* to an outbreeding system has yet to be elucidated.

The unusual expression of heterostyly in *Nivenia* and *Geissorhiza* merits further investigation, ranging from a documentation of the characters associated with heterostyly in these genera to an investigation of the presence and nature of an associated incompatibility system.

LINACEAE

Although distyly is widespread in the genus *Linum*, the South African species are apparently all homostylous (Alefeld, 1863; Winkler, 1931).

LYTHRACEAE

Of particular interest in South Africa is the genus *Nesaea*, which reportedly has dimorphic, trimorphic, and homostylous species in sections Hemiastrum and Salicariastrum (Koehne, 1903). For example, in section Salicariastrum, *N. schinzii* Koehne and *N. sagittifolia* (Sond.) Koehne are trimorphic, *N. woodii* Koehne is dimorphic, and such species as *N. kuntzei* Koehne and *N. rivularis* (Wood & Evans) Koehne are homomorphic. It is not clear whether all the homomorphic members of these sections are homostylous or whether their flowers are "morphologically heterostylous" and only one (presumably self-compatible) form persists. The evolutionary relationships between the heterostylous condition and the homomorphic condition (as well as the nature of the latter) would be very interesting to work out, especially in view of the similar relationships in floral morphology that exist among the species of the related

genus *Lythrum* (Darwin, 1877; Ornduff, unpub.) and in *Oxalis* section *Corniculatae* (Eiten, 1959, 1963; Ornduff, 1972). Field studies combined with a subsequent crossing program and study of the floral morphology of the southern African *Nesaea* species should provide some interesting insights into the comparative evolution of reproductive systems in this genus.

MENYANTHACEAE

The distyly of *Villarsia capensis* (Houtt.) Merrill and *Nymphoides thunbergiana* (Griseb.) O. Kuntze in South Africa has been noted by Marloth (1932a) and Marais and Verdoorn (1963). Self-pollinations of both species indicate that they are strongly self-incompatible. In Australia, where 12 species of *Villarsia* occur, only *V. exaltata* (Sol.) G. Don is distylous; the other species are homostylous (Aston, 1969) though not necessarily self-compatible (Ornduff, unpub.).

OLEACEAE

The two species of *Schrebera* in South Africa are heterostylous (Verdoorn, 1956; 1963). Verdoorn (1963) has also described distyly in South African species of *Jasminum*, although she states that the flowers are "usually" heterostylous. Her descriptions of the flowers of *J. multipartitum* Hochst. and *J. quinatum* Schinz indicate that these species definitely are distylous, but suggest the possibility that some other species might be monomorphic. Medley-Wood (1898) indicated that *J. streptopus* E. Mey. is dimorphic. My own observations of various South African species of the genus confirm Verdoorn's observations on two species and further indicate that *J. angulare* Vahl, *J. fluminense* Vell., *J. breviflorum* Harv., and *J. glaucum* (L.f.) Ait. are distylous. However, in some specimens of *J. fluminense* the stigma that terminates a very long style is only slightly exerted beyond the anthers, which are situated at the mouth of the corolla tube. In normal long-styled flowers the anthers are situated within the tube. It seems probable that the aberrant flowers represent plants that are long-homostylous, since plants with normal long-styled flowers also occur in this species.

OXALIDACEAE

Approximately half the world's species of *Oxalis* are endemic to South Africa and most of these are localized in the Cape Province. Jacquin (1794) was probably the first botanist to describe heterostyly in South African species of *Oxalis*, but he mistakenly interpreted the floral trimorphism to represent specific differences. Thus, *O. macrogyna* Jacq., *O. fallax* Jacq., and *O. luteola* Jacq. refer to the long-, mid-, and short-styled forms of *O. luteola*. Later, Hildebrand (1867) reported heterostyly in several South African species and

pointed out Jacquin's error. Salter (1944) stated that all the species native to South Africa are "probably" tristylous, though in some very rare species not all stylar forms have been observed. Likewise, Marloth (1925) stated unequivocally that "all indigenous species are trimorphic". My own investigations of several dozen species in the field, garden, and herbarium suggest that it is probably true that all South African species of the genus are morphologically tristylous (Fig. 3-5), but that this morphological heteromorphism is not always associated with outcrossing or with self-incompatibility.

Darwin (1877) reported that the short-styled form of *O. compressa* L.f. (section Cernuae) and of *O. "Bowii"* (the identity of which he questioned; = *O. bowiei* Lindl., section Cernuae?) produced no seed. The three forms of *O. "speciosa"* (= *O. purpurea* L., section Stictophyllae?) produced some seed by self- and other illegitimate pollinations, though seed production was lower than that of legitimate crosses, indicating that this species has a residual self-incompatibility. Hildebrand (fide Darwin, 1877) has suggested that the trimorphic *O. incarnata* L. (sect. Oppositae) produces cleistogamous flowers. I have not confirmed this in the populations that I have examined in the field and in cultivation. Salter (1944) reported that a mid-styled clone of *O. flava* L. (sect. Crassulae) grown at Kirstenbosch produced no seed, and that the short-styled form of *O. caprina* L. (sect. Cernuae), introduced and weedy on the Cape Peninsula, also produces no seed in the absence of other floral forms of the species. Likewise, Salter noted that isolated monomorphic populations of *O. pes-caprae* L. (sect. Cernuae) do not produce seed. In contrast, my studies indicate that the small-flowered *O. pusilla* Jacq. (sect. Angustatae), though structurally trimorphic, sets abundant seed through apparent spontaneous self-pollination. Results of artificially selfing the three floral forms of the closely related large-flowered *O. glabra* Thunb. (sect. Angustatae) indicate that this species is apparently self-incompatible.

Selfing of the three forms of *Oxalis disticha* Jacq. (Fig. 3-5), *O. dines* Ornduff, *O. uliginosa* Schlecht. (all sect. Campanulatae), and *O. massoniana* Salter (sect. Angustatae) produced no seed, indicating that these species are strongly self-incompatible. Selfing of long-styled plants of *O. obtusa* Jacq. (sect. Oppositae) and *O. purpurea* L., and of short-styled plants of *O. dregei* Sond. (sect. Campanulatae) produced no seed, suggesting that these species likewise are self-incompatible. Long-styled plants of *O. versicolor* L. (sect. Angustatae) produced some seed upon selfing. Thus, at least within the large section Angustatae, autogamy, self-compatibility, and self-incompatibility exist, though all species have heteromorphic flowers.

It seems probable that homostyly has not evolved in South African species of *Oxalis* as it has, for example, in the North American section Corniculatae (Ornduff, 1972) and in section Ionoxalis (Denton, 1973). Nevertheless, in some

species "effective homostyly" has been achieved by reduction in total floral size and the development of some mechanism which insures selfing (as in *O. pusilla*), though the mechanics of this remains to be demonstrated.

Hildebrand (1867) reported pollen size heteromorphism in the few South African *Oxalis* species available to him. My studies of 5 species belonging to 3 sections indicate pollen size heteromorphism is present in all of these species (Table 2). In general, pollen from the longest set of anthers is larger than that

TABLE 2.

Pollen size in South African *Oxalis* species, based on sample sizes of 20 pollen grains each. Average measurement and range (in parentheses) are given in microns.

Species and Locality (Cape Prov.)	Floral form	Long	Mid	Short
(Campanulatae):				
<i>O. disticha</i> 7297; Near Koperfontein	Long	—	44,4 (42,9–46,8)	37,7 (35,1–40,0)
	Mid	58,3 (50,7–62,4)	—	37,3 (35,1–41,0)
	Short	54,2 (53,0–57,5)	44,8 (42,9–46,8)	—
<i>O. dines</i> 7471; Botter- kloofpas	Long	—	40,5 (35,1–42,9)	36,6 (33,2–39,0)
	Mid	49,3 (44,9–52,6)	—	38,0 (35,1–41,0)
	Short	48,8 (44,8–54,6)	48,2 (44,8–50,7)	—
<i>O. uliginosa</i> 7209; Near Kamieskroon	Long	—	48,3 (41,0–52,6)	44,5 (39,0–48,8)
	Mid	57,8 (54,6–60,4)	—	39,0 (35,1–41,0)
	Short	56,8 (48,8–60,4)	47,3 (42,9–58,5)	—
(Angustatae):				
<i>O. massoniana</i> 7453; Near Nieuwoudtville	Long	—	38,3 (37,0–42,9)	32,5 (29,2–35,1)
	Mid	48,6 (44,8–54,6)	—	36,2 (33,2–39,0)
	Short	43,0 (39,0–46,8)	44,1 (37,0–52,6)	—
(Incertae Sedis):				
<i>O. monophylla</i> 7140; Lions Head, Cape Town	Long	—	44,2 (41,0–48,8)	35,8 (31,2–39,0)
	Mid	51,6 (39,0–56,6)	—	33,4 (29,2–35,1)
	Short	38,9 (37,0–44,8)	34,4 (33,2–39,0)	—

from the mid-level anthers, and pollen from the latter set of anthers is larger than that from the short-level anthers. A few exceptions exist, as for example in *O. dines* and *O. massoniana* where the pollen of mid- and long-level anthers is the same size. Furthermore, in some species there is not a good correspondence in pollen size from anthers at equivalent levels in two forms. For example, the pollen from long-level anthers of Mid and Short forms and from mid-level anthers of Long and Short forms does not correspond in size in *O. monophylla* L. and *O. massoniana*. The significance of these discrepancies is unknown and may merely represent an artifact of sampling. However, they may also suggest breeding systems that deviate from that expected in "normal" trimorphic species (cf. data for sect. Corniculatae, Ornduff, 1972).

Eighteen population samples of six *Oxalis* species were taken in the field in South Africa and the representation of the various stylar forms was determined in these populations (Table 3). Particular emphasis was placed on *O. pes-*

TABLE 3

Representation of floral forms in South African species of *Oxalis*. Equality decision is based on the Z test.

Species	Locality (Cape Prov.)	Long	Mid	Short	Equality
(Sect. <i>Angustatae</i>):					
<i>O. glabra</i> 7040	Disturbed roadside nr. Durbanville .	21	1	2	no
(Sect. <i>Oppositae</i>):					
<i>O. incarnata</i> 7271	Disturbed roadside, Kirstenbosch .	30	0	0	no
„ 7278	Oak woodland, Kirstenbosch . .	159	46	20	no
<i>O. obtusa</i> 7037	Between Stellenbosch and Paarl . .	21	32	22	yes
„ 7118	Steenbergs Cove	64	53	43	yes
<i>O. luteola</i> 7039	Between Klapmuts and Durbanville .	11	8	10	yes
„ 7087	Kenilworth race course, Cape Town .	40	40	21	no
„ 7106	N. of Olifantsbos	27	23	33	yes
(Sect. <i>Stictophyllae</i>):					
<i>O. purpurea</i> 7273	Weedy, Kirstenbosch	14	60	25	no
„ 7276	Non-weedy, Kirstenbosch	39	52	54	yes
(Sect. <i>Cernuae</i>):					
<i>O. compressa</i> 7286	Kalbaskraal	82	59	82	no
„ 7293	Between Malmesbury and Hopefield .	56	51	41	yes
<i>O. pes-caprae</i> 7038	Weedy, Klapmuts	12	38	31	no
„ 7041	Weedy, Stellenbosch	7	3	39	no
„ 7272	Weedy, Kirstenbosch	53	164	8	no
„ 7301	Non-weedy, between Hopefield and Langebaan	87	56	88	no
„ 7296	Non-weedy?, between Hopefield and Malmesbury	70	60	57	yes
„ 7292	Non-weedy?, between Hopefield and Malmesbury	59	49	56	yes
(Sect. <i>Campanulatae</i>):					
<i>O. disticha</i> 7297	Near Koperfontein	46	49	41	yes

caprae, a species that has a very wide distribution in South Africa. Outside South Africa, this species is a widely distributed and notorious introduced pest of arable lands in Australia, California, Britain, and the Mediterranean area (see Symon, 1961; Lower, 1963; Galil, 1967, 1968). Lower (1963) has suggested that the weedy strain of *O. pes-caprae* “is a sport, either artificial or natural, of the ‘maritime’ ecotype which has developed elsewhere”. Over most of its range as a weed, *O. pes-caprae* appears to be a sterile pentaploid (Yamashita, 1935; van der Pijl, 1968), though Symon (1961) indicates that seed is formed (presumably by fertile tetraploids) in some areas of South Australia where the species has been introduced. My own field observations indicate that in the relatively restricted area of the southwestern Cape Province, *O. pes-caprae* is both a well behaved native and a vineyard weed. In two of the three non-weedy populations examined, long-styled, mid-styled, and short-styled plants are present in equal numbers, but in the weedy populations these forms are unequally represented although such weedy plants are sexual (Table 3). In two of these weedy populations, mid-styled plants predominate. Similarly, a weedy

population of *O. purpurea* deviates from equality of representation, with Mids predominating, although in a non-weedy population of this species the three forms are present in a 1:1:1 ratio. Salter (1944) stated that "the short-styled form [of *O. incarnata*] appears to be very rare, if existent at all". In one population of *O. incarnata*, Longs only were present, but in another population the three floral forms were present, although Longs predominated. Overall, 10 of the 18 populations of various *Oxalis* species sampled deviate from equality.

There are at least two complementary explanations that can be offered to account for inequality of representation of the 3 floral forms in *Oxalis*. All indigenous South African *Oxalis* species are bulbous and probably most of these can reproduce asexually by means of increase in number of bulbs (Salter, 1944). My field observations of several species suggest that sexual reproduction by seeds is a rare event, and that much of the increase in population size is due to vegetative propagation. It is probable that sexual reproduction occurs largely after an ecological disturbance such as fire or clearing. Under these circumstances, severe reduction of size of the parental populations due to these ecological disturbances may result in inequality of genotypes due to chance, and one consequence of this is inequality of representation of the three forms in the succeeding, sexually produced generation as a result of this initial unbalance of founder genotypes. To this is added the possibility that some populations of *Oxalis* species may be established initially by the chance dispersal to a new site of one or few bulbils; this, followed by subsequent asexual reproduction, would also result in deviations from a 1:1:1 ratio of the three floral forms. In species that are weedy, such as *O. pes-caprae*, vegetative spread of one or a few genotypes in a population may be much enhanced by cultivation of the soil, and in a number of Cape vineyards that I visited, plants occurring for several metres along the rows of grape vines were of a single form, further confirming the suggestion that the propagation of such weeds is enhanced by cultivation.

PLUMBAGINACEAE

Distyly was reported for *Plumbago auriculata* Lam. (as *P. capensis* Thunb.) by Dahlgren (1918) and by Marloth (1932b) but not mentioned for any species in the genus by Dyer (1963). Baker (1953) reports that five species of *Limonium* sect. *Limonium* in the Cape are dimorphic but that the four species of the exclusively South African section *Circinaria* are monomorphic. Dahlgren (1970) has reported distyly in *Dyerophytum indicum* (Gibbs ex Wight) O. Kuntze but Dyer (1963) makes no mention of this trait for *D. africanum* (Lam.) O. Kuntze.

PONTEDERIACEAE

Tristyly has been reported for some species of *Heteranthera*, but Marloth (1915) reports that cleistogamy occurs in the South African *H. kotschyana*

Fenzl, indicating that this species is probably monomorphic. Although *Eichhornia crassipes* is not native to Africa, it is a troublesome weed in parts of the Republic and in South West Africa. Wild (1961) reports erroneously that the styles of this species are "sometimes of three different lengths in the same plant". There have been repeated reports of tristylous for this species, but there is no evidence that the short-styled form exists (see Ornduff, 1966), and in any case only a single type of flower is borne by each individual plant.

RUBIACEAE

The largest number of heterostylous genera of any angiosperm family occurs in Rubiaceae (Vuilleumier, 1967). In South Africa, species such as *Oldenlandia rupicola* (Sond.) O. Ktze., *O. muscosa* Brem., and *O. affinis* (R. & S.) DC. are distylous, whereas others, such as *O. corymbosa* L., *O. capensis* L.f., and *O. caespitosa* Hiern. are homostylous (Bremekamp, 1952; Bir Bahadur, 1968). In some species, such as *O. rosulata* K. Sch. and *O. herbacea* (L.) Roxb. there are heterostylous varieties and other, homostylous ones.

Pentodon pentander (Schum.) Vatke, *Agathisanthemum bojeri* Klotzch, *Amphiasma merenskyanum* Brem., and *A. divaricatum* (Engl.) Brem. are distylous (Bremekamp, 1952). *Pentanisia variabilis* Haw. is reportedly distylous and *Tricalysia sonderiana* Hiern. is seemingly homostylous (Medley-Wood, 1902). I have seen no reports concerning distyly in South African representatives of *Spermacoce*, *Borreria*, *Anthospermum*, *Grumilea*, *Mussaenda*, or *Pentas*, genera for which distyly has been reported in species that occur elsewhere (Vuilleumier, 1967).

SANTALACEAE

Hill (1915) suggested the "possibility" that heterostyly may occur in *Thesium*, although the floral morphology of two species was "not quite convincing". Levyns (1940) stated that "it is clear that the phenomenon of heterostyly is not a feature of these plants". It is possible that interspecific differences in relative lengths of styles and stamens might have been responsible for Hill's supposition.

TURNERACEAE

Heterostyly is widespread in Turneraceae and is associated with a strong incompatibility system in the New World *Piriqueta caroliniana* (Walt.) Urb. (Ornduff & Perry, 1964) and *Turnera ulmifolia* L. (Lock, 1904; Martin, 1965). In South Africa, *Wormskiodia longipedunculata* Maxw. is distylous. Various features of its floral morphology have been documented and illustrated by Vogel (1955) although it is unknown whether this species has an incompatibility system. The closely related *W. pilosa* Schweinf. is homostylous (Urban, 1883) and, by analogy with homostylous species in other genera of the family,

it is probably self-compatible. The description given of *Turnera oculata* Story suggests that it is homostylous (Story, 1961).

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CELL DIVISION-INDUCING SUBSTANCES IN THE LIQUID ENDOSPERM OF *HYPHAENE NATALENSIS*

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ABSTRACT

The presence of at least two cell division-inducing compounds in the liquid endosperm of *Hyphaene natalensis* was indicated by results obtained in the soybean bioassay. Most of the activity is attributable to a butanol-soluble compound that co-elutes with zeatin riboside on a Sephadex LH-20 column.

UITTREKSEL

SELDELINGS-STIMULEERDERS IN DIE VLOEIBARE ENDOSPERM VAN *HYPHAENE NATALENSIS*

Met behulp van die sojaboonkallus-biotoets is gevind dat die vloeibare endosperm van *Hyphaene natalensis* minstens twee seldelings-stimuleerders bevat. Die meeste van die aktiwiteit is toe te skryf aan 'n butanol-oplosbare verbinding met dieselfde elueringspatroon, op Sephadex LH-20, as zeatienribosied.

INTRODUCTION

Hyphaene natalensis Kunze, commonly known as the ilala palm or ivory nut palm grows along the Natal coast and also in the inland lowveld areas of Tongaland in northernmost Natal. The fruits which are borne on branched inflorescences, are pear-shaped and remain on the tree for a long time, usually taking two or more years to reach maturity. In the early stages of development the endosperm, as in other palm fruits, is liquid. In the case of *Cocos nucifera* L. this liquid endosperm is extremely rich in growth promoting substances e.g. cytokinins (Letham, 1968) and for this reason is frequently used as an additive in plant tissue culture experiments. The present study was conducted to determine whether the liquid endosperm of *Hyphaene natalensis* contains similar substances.

EXPERIMENTS AND RESULTS

The fruits of *Hyphaene natalensis* collected in Tongaland during April, 1973, and used in the present investigation, each yielded between three and four millilitres of liquid endosperm ("milk"). In order to establish whether this milk contained any cell division-inducing substances a series of dilutions, ranging from 0.01%–10% of the culture medium was assayed for cell division activity

with the soybean bioassay (Miller, 1965). For comparison a series of dilutions of coconut milk was assayed simultaneously. Figure 1 shows that ilala milk does contain substances that enhance the growth of soybean callus. The concentration of these substances is apparently much lower than in coconut milk as 0.1% coconut milk gave a better response than any of the concentrations of ilala milk used. With ilala milk the highest activity was recorded when it constituted 5% of the culture medium. Higher concentrations depressed growth, probably as a result of inhibiting or interfering substances which offset the effect of the growth promoting compounds. That phenolic compounds could be involved is suggested by the fact that the culture medium containing 7.5% and 10% ilala milk respectively turned brown upon autoclaving. In order to eliminate interfering compounds and obtain more information about the nature of the cell division-inducing compounds involved, 600 ml of ilala milk was concentrated to 100 ml under vacuum at 40°C. The concentrated solution was partitioned against water-saturated n-butanol at pH 7.0 in order to separate the butanol-soluble free base and riboside cytokinins from the water-soluble cytokinin ribotides. The resultant aqueous and butanol extracts were reduced to dryness *in vacuo* at 35°C, taken up in a small volume of 35% ethanol and then streaked onto Whatman 3 MM chromatography paper. Chromatograms were developed in *iso*-propanol: ammonia:water (10:1:1 v/v), dried and divided into 10 equal R_f zones. The equivalent of 300 ml milk was assayed in 40 ml medium, and cultured for a period of 28 days.

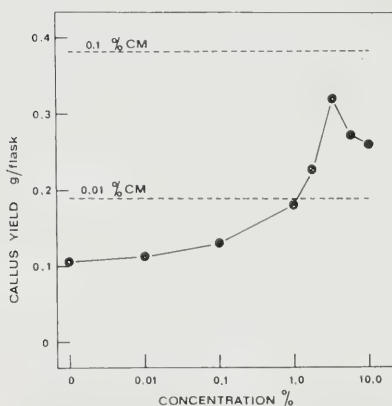


FIG. 1.

Relationship between the concentration of ilala milk and the growth of soybean callus. CM = coconut milk.

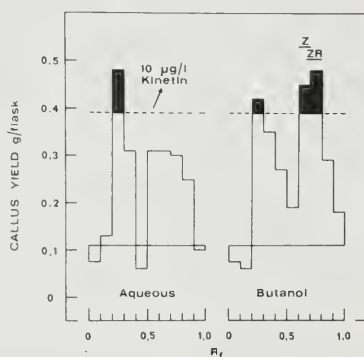


FIG. 2.

Soybean bioassay of aqueous and butanol extracts of 300 ml equivalents of ilala milk. Solvent: *iso*-Propanol: ammonia: water (10:1:1 v/v). The position of zeatin (Z) and zeatin riboside (ZR) when run as markers, are indicated.

Substances that enhance the growth of soybean callus were present in both the aqueous and butanol extracts (Fig. 2). In the aqueous extract the major peak of activity was found between Rf 0,2–0,3. Two peaks of activity were found in the butanol extract. One was slow-moving and occurred in the same region of the chromatogram as the active compounds in the aqueous extract. This activity was in all probability due to water-soluble cytokinins passing into the butanol during partitioning. The second peak of activity occurred between Rf 0,6–0,8, that is in the region where cytokinin ribosides and their free bases are expected to occur. In agreement with the paper chromatographic results, fractionation of a butanol extract, from 500 ml equivalent of ilala milk, on Sephadex LH-20 (Van Staden, Webb and Wareing, 1972) with 35% ethanol, resulted in two major peaks of activity (Fig. 3). Activity in the bioassays was regarded as being significant when growth higher than that recorded for 10 $\mu\text{g/l}$ kinetin equivalents was recorded. Most of the activity is apparently due to a compound which is similar, or has the same elution volume on Sephadex, as zeatin riboside. The second peak eluted from the column very rapidly (200–240 ml) and did not co-chromatograph with available naturally-occurring cytokinin markers. Indications are that activity in this region of the chromatogram could be due to the

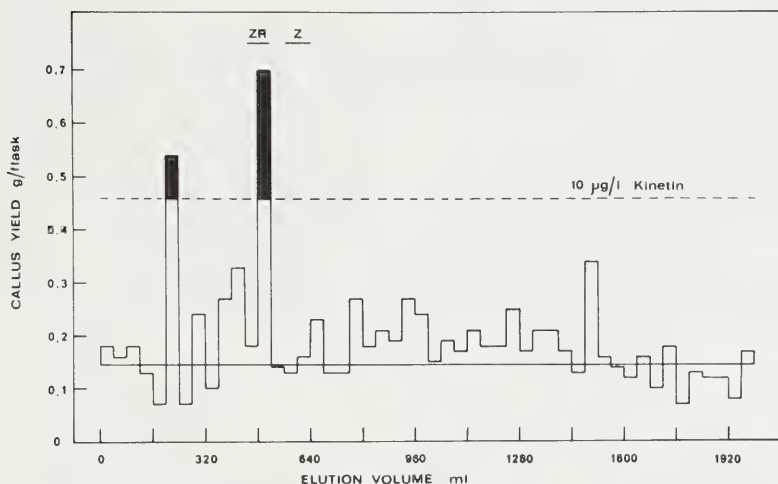


FIG. 3.

Soybean bioassay of a butanol extract of ilala milk (500 ml) after partition chromatography on Sephadex LH-20. The position of zeatin riboside (ZR) and zeatin (Z) when run as markers are indicated.

presence of cytokinin ribotides. This is substantiated by the fact that elution of the peak from aqueous extracts after paper chromatography (Rf 0,2–0,3 in Fig. 2), and its subsequent fractionation of Sephadex LH-20, yielded one peak of activity with the same elution characteristics.

DISCUSSION

Both water and butanol-soluble cytokinin-like substances were present in the liquid endosperm of the ilala palm. Most of the activity is apparently due to the presence of a compound which is similar or has the same chromatographic characteristics as zeatin riboside. This is in agreement with results obtained for the coconut palm in that the major active compound in its liquid endosperm was identified as 9- β -D-ribofuranosylzeatin (Letham, 1968). The total cytokinin activity recorded for ilala milk however, appears to be more than 50 times less than that recorded for coconut milk. This finding was substantiated further by additional paper and column chromatographic techniques (unpublished data). The low cell division activity, presence of large amounts of phenolic substances, and the low yield of milk per fruit suggests that it would not be feasible to use ilala milk as an additive to induce cell division in plant tissue culture experiments.

ACKNOWLEDGEMENTS

The financial assistance of the CSIR, Pretoria, is gratefully acknowledged. Dr. C. M. Breen is thanked for collecting the ilala fruits.

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ABSCISSION OF LEAVES IN *GREYIA* HOOK. & HARV.

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ABSTRACT

Longitudinal cortical ridges on the internodes of *Greyia* Hook. & Harv. give an erroneous impression of sheathing leaves. During abscission the epidermis and cortex of the stem abscise with the leaves. The separation layer, as well as the phellogen of the protective layer, is already present in the shoot apex. The phellogen originates in the pericycle.

UITTREKSEL

AFSNOERING VAN BLARE BY *GREYIA* HOOK. & HARV.

Lengteverlopende korteksriwwe op die stingellitte van *Greyia* Hook. & Harv. skep 'n vals indruk van blaarskedes. Gedurende blaarval word die stingelepidermis en -korteks saam met die blare afgesnoer. Die skeidingslaag, sowel as die fellogeen van die beskermingslaag, is reeds in die stingelgroeipunt aanwesig. Die fellogeen ontstaan in die perisikel.

INTRODUCTION

Greyia Hook. & Harv., an endemic genus, closely related to *Bersama* Fresen and *Melianthus* Linn. (Scholz, 1964), is represented in South Africa by three species, viz. *G. sutherlandii* Hook. & Harv., *G. radlkoferi* Szyszyl and *G. flanaganii* H. Bol. The first two species are shrubby, deciduous trees, while *G. flanaganii* is an evergreen shrub.

The leaves of *Greyia* are subrotund or heart-shaped and palmately veined with cylindrical petioles. The leaf bases are dilated and partly encircle the nodes. Organographically, however, each leaf seems to continue as a long sheath lying close to the stem and extending through the entire preceding internode (fig. 1). This characteristic of *Greyia* is regarded by Hutchinson (1959) as "petioles sheathing at the base", while Phillips (1951) mentions "petioles dilated at the base".

At the end of the growing season the leaves of *G. sutherlandii* and *G. radlkoferi* abscise acropetally along the leaf bearing shoots. Abscission of a leaf does not, however, occur at the leaf base, but commences at the margins of the "sheath", near the base of the preceding internode (fig. 2). In this way, the appearance of a sheathing leaf is heightened.

Although *G. flanaganii* is not deciduous, older leaves abscise in the same way.

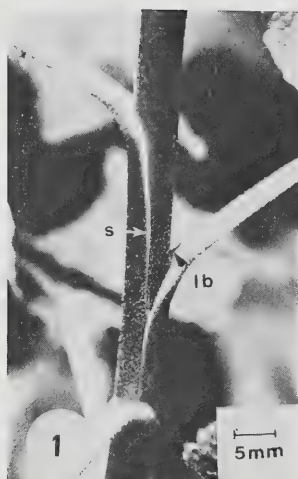


FIG. 1.

A part of the one year old shoot of *Greyia flanaganii*, illustrating the leaf base and "leaf sheath": lb, leaf base; s, "sheath".



FIG. 2.

A part of the one year old shoot of *G. sutherlandii* illustrating the abscising tissues: bi, base of internode; s, "sheath".

An anatomical study of the stems of all three species of *Greyia* was therefore undertaken to investigate the interesting and unusual abscission phenomenon found in this genus.

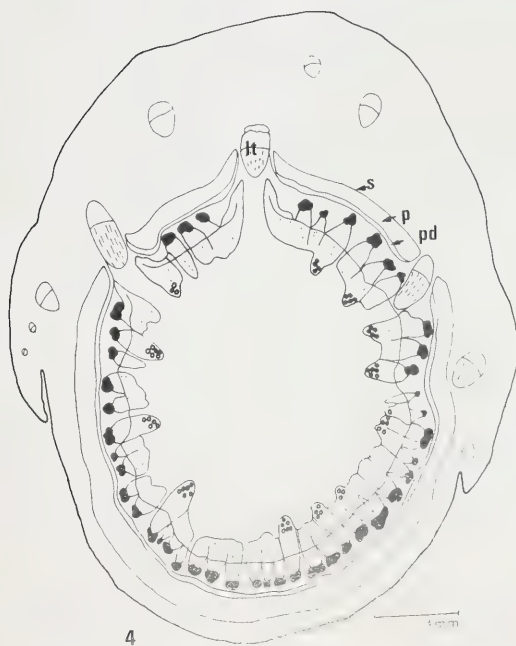
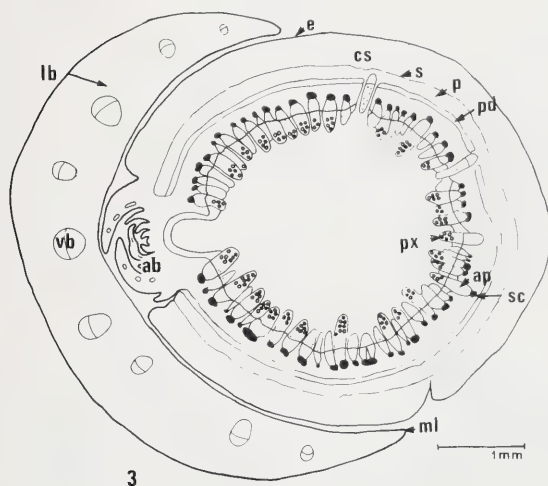
MATERIAL AND METHODS

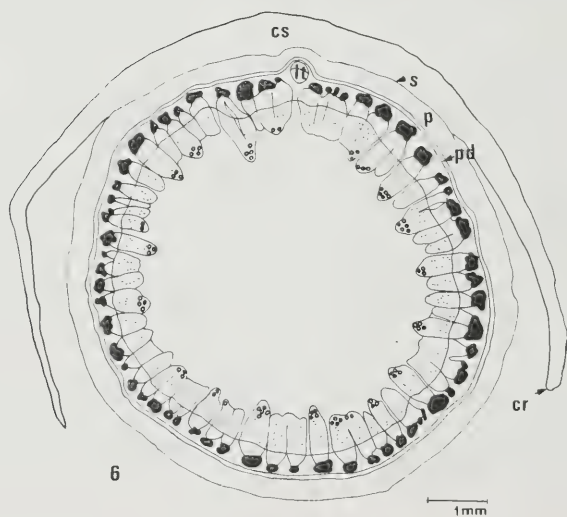
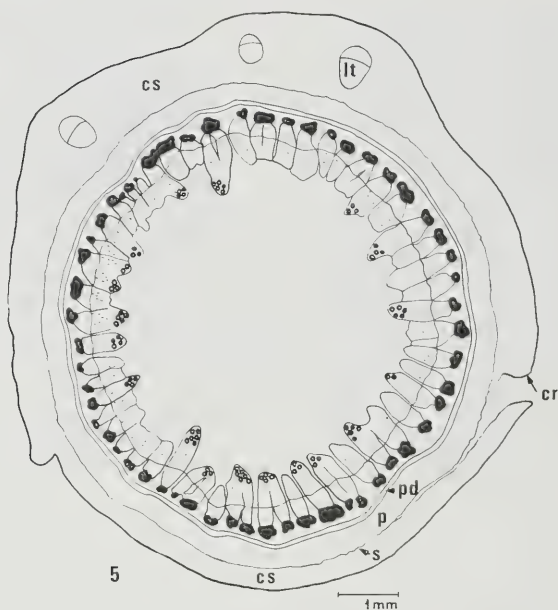
Stem apices and segments of one year old shoots of all three species of *Greyia* Hook. & Harv. were fixed during June 1973 in 6% glutaraldehyde at 0°C in a 0.025 M phosphate buffer at pH 6.8 (Feder and O'Brien, 1968) and in formalin-acetic acid-alcohol (F.A.A.). After dehydration and impregnation with either wax or a mixture of glycol methacrylate (Ashley and Feder, 1966), transverse sections were cut.

Wax sections were stained with safranin and "Fast Green FCF" (Gürr, 1965) and glycol methacrylate sections were stained with "Periodic Acid" Schiff's reagent and toluidine blue (Feder and O'Brien, 1968).

FIGS 3-6.

Diagrams of transections of the stem of *Greyia* during abscission: 3, distal part of node with crescent-shaped leaf base; 4, basal part of node with diverging leaf traces; 5, median part of internode with break in separation layer starting at cortical ridge; 6, basal part of internode with pronounced break in separation layer: ab, axillary bud; ap, axial phloem group; cr, cortical ridge; cs, cortex of stem; e, epidermis; lb, leaf base; lt, leaf trace; ml, margin of leaf base; p, phellem; pd, phelloderm; px, primary xylem; s, separation layer; sc, sclerenchyma; vb, vascular bundle.





ANATOMICAL INVESTIGATION

A series of transverse sections of the one year old stem of *Greyia* reveals that the leaf has no sheath, but is connected to the stem at the node (figs. 3 & 4). The dilated, crescent-shaped leaf base partly encircles the node and the margins of the leaf base coincide with longitudinal ridges (figs. 4 and 5) on the internode. These ridges form the "margins" of the "leaf sheath" (fig. 1). The latter, therefore, is actually a broadened part of the cortex of the stem (figs. 4 & 5) which contains the leaf traces.

The leaf traces, which constitute the vascular supply of the leaf base (fig. 3), diverge at different levels of the internode from the vascular system of the stem to continue in the cortex. The first leaf trace branches off early, practically in the preceding node (fig. 6). In the median part of the internode three leaf traces

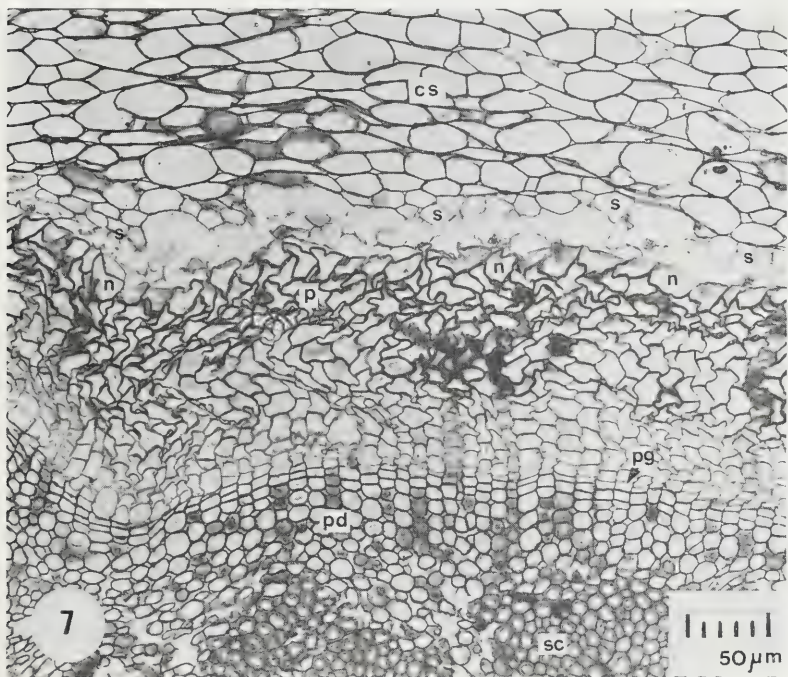


FIG. 7.

A part of a transection of the stem of *G. sutherlandii* illustrating the abscission zone; cs, cortex of stem; n, endodermis; p, phellem; pd, phelloderm; pg, phellogen; s, separation layer; sc, sclerenchyma group.

occur in the cortex (fig. 5). At the base of the node the remaining leaf traces are deflected into the leaf base (fig. 4).

During abscission the epidermis and the cortex abscise with the leaves. Abscission of these tissues commences at the base of the preceding internode (figs. 2 and 6) at the cortical ridges and the break in the tissues spreads around the circumference of the stem and acropetally towards the leaf bearing node (figs. 2, 5 and 6). In the vicinity of this node the epidermis and cortex are therefore still connected to the internal tissue of the stem although the abscission zone is already well developed (figs. 3 & 4).

According to Esau (1965), the abscission zone of the leaf consists of a separation layer, in which the actual break occurs, and a protective layer. In *Greyia* the periderm of the stem acts as the protective layer and comprises a multi-

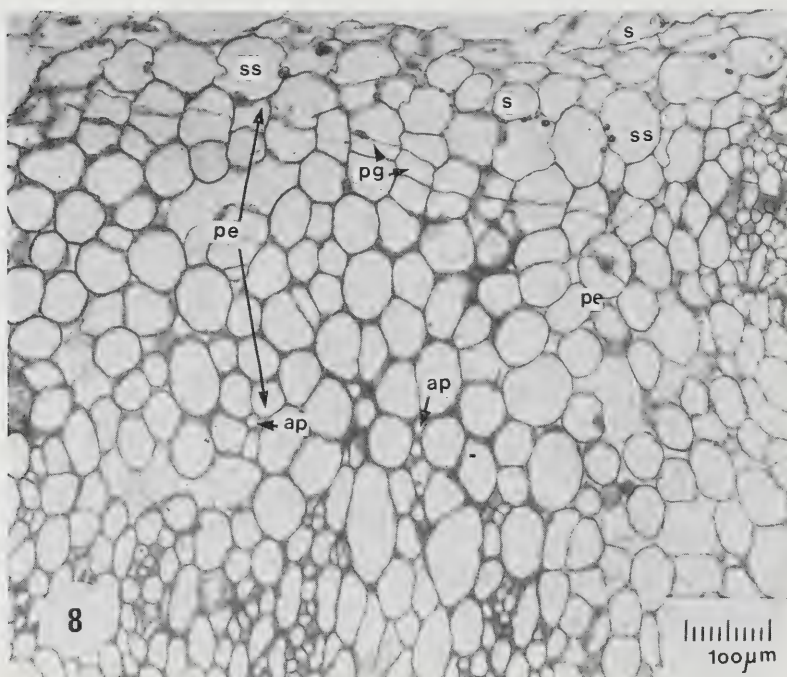


FIG. 8.

A part of a transection, approximately 300 μm below the promeristem, of the shoot of *G. radlkoferi* illustrating the starch sheath and origin of the phellogen: ap, axial phloem elements; pg, phellogen; pe, pericycle; s, separation layer; ss, starch sheath.

seriate layer of thin-walled, air-filled phellem cells, a phellogen layer and several layers of thin-walled phelloderm cells. The latter practically border the sclerenchyma caps lying on the outside of the axial phloem groups (fig. 7).

The phellogen, from which the protective layer arises, develops early in the ontogeny of the stem—the first traces of this meristem can already be seen in transections of the shoot apex, inside the starch sheath (fig. 8), which later becomes the endodermis (fig. 7). The dividing cells border the outermost axial phloem elements or may be separated from the latter by one to several layers of thin-walled cells, representing the pericycle.

The phellogen in the stem of *Greyia* therefore develops from the outermost layer of pericycle cells.

No specialized separation layer is formed in the leaf base of *Greyia* as often is the case in woody plants (Esau, 1965), but the inner cortical cells of the stem, through which the break occurs, are smaller, with thinner cell walls, than the adjoining cells of the cortex (fig. 7). The cell walls may therefore be mechanically weaker. This tissue can already be distinguished in the young stem on the outside of the starch sheath (fig. 8). Even in the stem apex the primordial leaves can easily be torn off in this region.

In the one year old shoot, therefore, the endodermis is that cell layer lying immediately outside the first layer of phellem cells and separating the latter from the inner cells of the separation layer. The endodermal cells contain no starch and the cell walls are thin and unlignified. The cells, however, are usually not destroyed during abscission, but remain attached to the periderm layer.

The reason for the unusual abscission phenomenon exhibited by *Greyia*, where the epidermis and cortex abscise with the leaves, therefore lies in the early development and the deep origin of a continuous abscission zone for all the leaves. The separation layer, as well as the phellogen of the protective layer, is already present in the extremely young shoot and extends throughout the nodes and internodes of the stem, in the vicinity of the endodermis. At the end of the growing season all the tissues outside the protective layer die off and abscise.

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DIE SUID-AFRIKAANSE GENUS *SYRINGODEA*

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UITTREKSEL

Vir hierdie monografie van die genus *Syringodea* (Iridaceae) is herbariummateriaal en lewende plante in hul natuurlike habitats bestudeer. Behalwe die uitwendige morfologie, is ook die anatomie van die blare en knoltunicae, die testa-ornamentasie en die chromosome ondersoek, wat heelwat bruikbare gegewens opgelewer het om die spesies en spesiesgroepe te onderskei. Twee subgenera word ingestel, die een met sewe spesies en die ander, subgenus *Rhipidopsis*, met één. Twee nuwe spesies word beskryf. Geïllustreerde beskrywings van al die spesies, hul geografiese verspreiding en sinonimie word verskaf, asook 'n sleutel.

'n Nuwe vorm van sklereïd, in die vorm van 'n plat reghoekige figuur, is gevind in die knoltunicae van *S. unifolia*; die term platysklereïd word hiervoor aangegee.

ABSTRACT

THE SOUTH AFRICAN GENUS *SYRINGODEA*

Herbarium specimens and living plants from their natural habitats have been studied for this monograph of the genus *Syringodea* (Iridaceae). To supplement the external morphological data the anatomy of the leaves and corm tunics, the ornamentation on the seed coats, and the chromosomes have been investigated and provide some useful diagnostic characters for delimiting species and species groups. Two subgenera are established, one comprising seven species and the other, subgenus *Rhipidopsis*, a single species. Two new species are described. Illustrated descriptions of the species, their geographic ranges, and synonymy are given and a key is provided. A new type of sclereid, in shape a flat rectangular figure, has been found in the corm tunics of *S. unifolia*; the term platysclereid is proposed for this.

INLEIDING

Syringodea Hooker f. is 'n klein, betreklik onbekende genus vand die Iridaceae, endemies in Suid-Afrika. Dit kom hoofsaaklik in die droër dele van die Republiek voor, t.w. die Karoo en Klein-Karoo. Die plante is klein geofiete met gereduseerde stingels en pedunculi, en die blomme, met vrugbeginsels ondergronds verberg, het lang smal blomdekbuis. Die genus is verwant aan *Romulea* en die twee het moontlik uit dieselfde oervorm gestam; dit is egter meer gespesialiseer as *Romulea*. In groeivorm stem dit tot 'n mate ooreen met die genus *Crocus* van die noordelike halfrond, maar verskil veral in blaar- en knoltunica-bou.

Die laaste verwerking van die genus was dié van Baker in die *Flora Capensis* (1896). 'n Hersiening is noodsaaklik, daar verskeie nuwe spesies ná 1896 beskryf is; daar is egter meer spesiesname gepubliseer as wat daar aparte spesies is, en 'n paar spesies wat in ander genera tuishoort, is ongelukkig onder *Syringodea* geplaas.

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Herbariummateriaal uit die volgende herbaria is vir hierdie ondersoek bestudeer: die herbaria van die British Museum (BM), Kew-tuine (K), Conservatoire et Jardin Botanique, Genève (G), Museum National d'Histoire Naturelle, Parys (P), Naturhistoriska Riksmuseet, Stockholm (S), en die Botaniese Museum, Berlin-Dahlem (B); asook die Bolus-herbarium, Universiteit van Kaapstad (BOL), Compton-herbarium (NBG) en Suid-Afrikaanse Museum-herbarium (SAM) te Kirstenbosch, Nasionale herbarium, Pretoria (PRE) en sy takke te Grahamstad (GRA) en Stellenbosch (STE). Verder is vars materiaal van al die spesies, met die uitsondering van één, versamel en bestudeer. Om die ietwat karige uitwendig-morfologiese kenmerke vir die onderskeiding van die spesies aan te vul, is ook die anatomie van die blare en knoltunicae en die chromosome ondersoek. Die ornamentasie van die testas het 'n bruikbare diagnostiese kenmerk opgelewer om die spesies in groepe te onderskei.

MORFOLOGIE

Habitus. Die plante is klein, tussen drie en vyftien sentimeter hoog. Vanaf einde Januarie tot begin April, afhangende van die reëns en die spesie, verskyn 'n groepie bywortels vanuit die basale rif van die rustende gerokte knol; wanneer dit te hoog is, ontwikkel ook 'n trekswortel om die jong knol op 'n geskikte diepte onder die grond te vestig. Gou daarna ontwikkel die spruit met 'n baie kort ondergrondse stingel, en een tot verskeie grondstandige loofblare. Vanaf Maart tot Junie blom die plante, dikwels voordat die loofblare hulle volwasse lengte bereik het. Behalwe die stingel, is ook die kort pedunculi, die blaar-basisse en blom-basisse ondergronds verberg. Die blomme, wat min of meer ná mekaar verskyn, word bo die grond opgestoot deur hul lang regop blom-dekbuis.

Die voedsel van die knol word opgebruik vir die vorming van die spruit. Die voedsel deur die nuwe blare vervaardig, word versamel in die stingelbasis wat geleidelik opswel om 'n nuwe knol vir die volgende seisoen te vorm.

Tussen Augustus en Oktober is die sade ryp en verskyn die toppe van die doosvrugte bo die grond. Behalwe vir een spesie, spring die vrugte oop nadat hulle deurweek is. Hoe die plante die soms jarelange droogtes oorleef, is onbekend—moontlik slegs in die vorm van saad.

Die gerokte knol. Die Syringodea-knol is die tipiese Ixiace-knol wat uit twee of meer kort ondergrondse basale litte van die as gevorm word. Die wortels spruit uit die knolbasis en funksioneer vir die hele seisoen selfs nadat die knol leeggemaak is van sy reserwes. Die boonste okselknop van die knol ontwikkel tot 'n spruit waarvan die basis opswel om die nuwe knol te vorm; dit wil sê, die groei van die plant is simpodiaal.

Die Syringodea-knol toon duidelike verwantskap met veral die ciliata-knoltype van *Romulea* (de Vos, 1970, 1972), in sy asimmetriese vorm (plagio-

troop, dorsiventraal, met 'n laterale aanhegting aan die ou knol van die vorige jaar en 'n skerp rif aan die basis), en in sy harde verhoue, kontinue knoltunicae wat die knol bedek en wat op die basale rif in fyn parallelle fibrille splits om die wortels deur te laat, en aan die top in skerp tande of onreëlmatige splits. Behalwe die harde tunica is daar ook een of meer sagte, membraanagtige bruin tunicae rondom die knol.

Die knol bestaan uit een (*S. unifolia*) tot ongeveer vier (*S. pulchella*) opgeswelde basale internodia van die spruit. Die meestal twee membraneuse laagteblare (basale skedes) en die basisse van die onderste een tot vier loofblare is geslote en vorm die knoltunicae. By *S. pulchella* bedek die laagteblare en die onderste twee loofblaarbasisse die knol geheel en al of byna heeltemal; die derde loofblaar is om die middel van die knol vasgeheg, en die vierde slegs om die top daarvan (Fig. 1a). By *S. unifolia* word die knol deur twee laagteblare en die enkele loofblaarbasis bedek; die laasgenoemde vorm die harde tunica en die ander vorm membraneuse tunicae.

Anders as by *Romulea* (de Vos, 1970, 1972) kom hier slegs twee knoltipes voor:

1. By die subgenus *Syringodea* het die knol 'n betreklik klein basale ruffie. By die seksie *Syringodea* is die ruffie besonder klein vir die grootte van die knol en maak dit die knol byna puntig aan sy basis (Fig. 1b). Dit herinner aan die *R. autumnalis*-knoltipe. By die seksie *Saxatiles* is die rif groter maar nie breër as die knol self nie (Fig. 1c-e), ongeveer soos by die *R. ciliata*-knoltipe. Soos by *Romulea*, is hierdie waarskynlik die primitiefste vir die genus.

2. By die subgenus *Rhipidopsis* is die knol vertikaal afgeplat en byna lensvormig met twee konvekse tunica-"kleppe" wat 'n wye, waaiervormige vertikale rif om byna die hele knol vorm, op die naat tussen die twee kleppe (Fig. 1f). Op die rif is die tunicae gesplits in fyn parallelle fibrille waartussen die wortels verskyn. Die ouderdom van die knol kan bepaal word deur die opmekaar liggende harde tunicae te tel, aangesien die enkele loofblaar jaarliks slegs één harde tunica vorm. Hierdie knol herinner aan die *Romulea tortuosa*-knoltipe.

By die seksie *Saxatiles* ontwikkel die knol, wanneer dit 'n sekere grootte bereik, dikwels tot 'n digte groep van twee tot ses of meer klein knolle wat gedeeltelik bedek bly onder die tunicae van die oorspronklike knol, en wat elk sy eie spruit met blare en blomme vorm. Dit gebeur wanneer meer as een van die okselknoppe op die ou knol verder ontwikkel en groei. By die ander spesies kom sulke knolgroepe selde voor.

Die spruitbasis bo die knol, asook die basisse van die blomme, word beskerm deur 'n digte massa ou bruin blaarbasisse van vorige jare, wat 'n kraag van een tot sewe sentimeter lank vorm.

Die stingel. Syringodea is deur Phillips (1951) beskryf as stingelloos; maar dit is beter om te sê dat die stingel kort is, onsigbaar verberg deur die kraag van ou blaarbasisse onder die grond. Dit wissel van 0,5 tot 4 of 5 cm in lengte, afhangende van die diepte van die knol onder die grond. Hierdie stingel be-

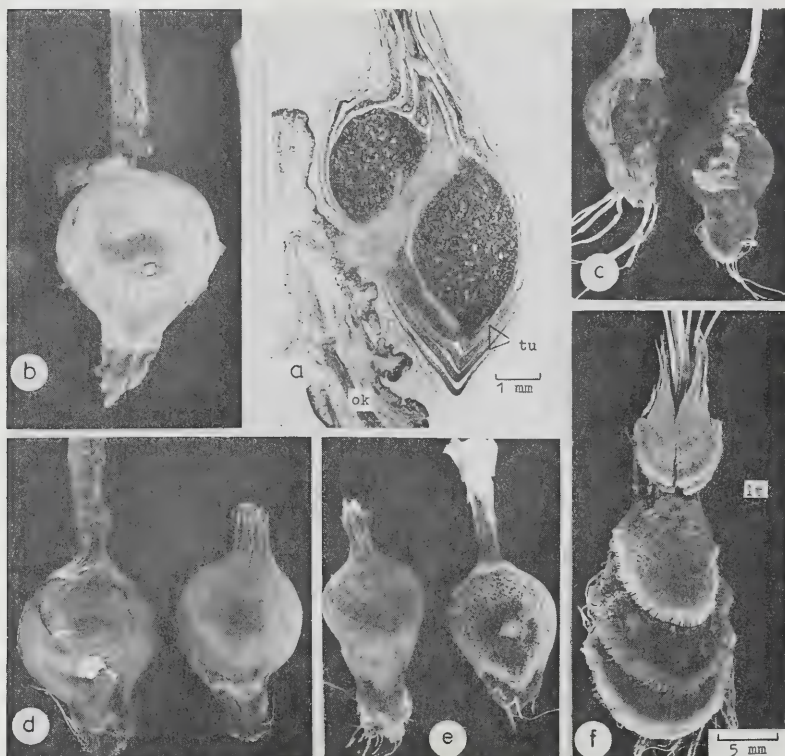


FIG. 1.

Syringodea-knolle: a, lengtesnee deur die knol van *S. pulchella*: ok, ou knol; tu, tunicae; b, *S. pulchella*; c, *S. longituba*; d, *S. concolor*; e, *S. derustensis*; f, *S. unifolia*: lt, los tunicae van vorige jare.

staan uit 'n paar internodia, met 'n loofblaar of 'n membraneuse skutblaar op elke nodus; dit vertak meestal met 'n paar kort sytakke, die pedunculi, elk met een eindstandige blom omhul in sy eie tweekleppige bloeiskede (sien verder onder *Bloeiwyse*).

Die blare. Die loofblare kan as grondstandig beskryf word, die meeste afkomstig van die nodi van die knol en enkele van die nodi op die stingel, bv. by *S. longituba*. Hulle vorm 'n spirodistieche roset van vier tot agt of soms meer blare, behalwe by twee spesies, *S. unifolia* en *S. saxatilis*, wat eenblarig is. Anders as by ander Ixieae, is die blare grotendeels bifasiaal, deur die vergroting van die blaarskedes en reduksie van die unifasiale deel.

By die seksie *Syringodea* is die blare langer as die hoogte van die blomme bo die grond. By die seksie *Saxatiles* steek die blomme meestal bo die blaarroset uit, maar ná die antese verleng die blare gewoonlik verder; hier is die blare dikwels gebuig, opgekrul, gekartel of geroteer met 'n regsom torsie.

Soos Arber (1921) vir *S. bicolor* aangetoon het, verskil die volwasse *Syringodea*-blaar van dié van *Romulea* in sy grotendeels bifasiale vorm en in die afwesigheid van vier diagonale lengtegroewe. Dit is effens opgeswel en nagenoeg filiform, of platterig met die abaksiale kant meestal konveks en die adaksiale kant met 'n mediane lengtegroef of plat. Jong eenblarige kiemplante, of by die twee eenblarige spesies selfs die ouer plante wat nog nie blom nie, het unifasiale, terete blare (Fig. 16, 17). So gou 'n tweede blaar of 'n blom moet verskyn, verdwyn hierdie unifasiale toestand, behalwe by die blaartoppe wat by sommige spesies, soos *S. pulchella*, unifasiaal bly (die sg. "Vorläuferspitze" van Troll, 1939). Die *Syringodea*-blaar is vergelykbaar met die blaarskede van die *Romulea*-blaar wat ook bifasiaal en sonder lengtegroewe is.

Meestal is die blaarrande gesileerd met 'n ry kort trichome. By die tipe van *S. filifolia* is die hare baie kort en slegs met 'n lens sigbaar. Baker (1876a) het hierdie blare as naak beskryf.

Onder die loofblare kom twee, of soms een, nie-groen, membraneuse laagteblare (basale skedes) voor wat verberg is onder die kraag van ou blaarbasisse, behalwe vir hul breed-skerp punte wat soms uitsteek. Hulle toon geen diagnostiese kenmerke om die spesies uit te ken nie. Hulle, asook die skedes van die onderste loofblare, is breed en geslote rondom die knol en stingelbasis, en ontstaan waar die nuwe knol aan die oue geheg is. Die hoër loofblare het smal, oop skedes.

Die bloeiwyse. Die bepaalde bloeiwyse is basies soos by *Romulea* (de Vos, 1971), behalwe dat die pedunculi baie korter is en steeds verberg bly. Elke blom is terminaal en word enkeld en sittend gedra bo 'n skutblaar en skutblaartjie, op 'n kort takkie, die pedunculus. Lewis (1954) se sienswyse word hier gevolg om die hoofas bokant die sytakke, asook die sytakke, almal as aparte pedunculi te beskou, daar elk 'n gereduseerde bloeiwysetak voorstel. Die kort pedunculi, slegs 5 mm tot ongeveer 15 mm lank, kom in pare voor, elke paar in 'n monochasiale rangskikking. Die blomme, twee tot vyf of soms meer in getal, verskyn min of meer na mekaar. Die pedunculus van die eerste blom is die top van die hoofas en die tweede is die boonste sytak; die volgende twee blomme is aan die

tweede boonste sytak en dié se vertakking, ensovoorts. By *S. pulchella* en *S. unifolia* ontstaan elke sytak (pedunculus) in die oksel van 'n lang membraneuse skutblaar, met 'n membraneuse profil tussen die sytak en die hoofas. By *S. longituba* is hierdie skutblare loofblaaragtig maar korter en dunner as die basale loofblare.

Die skutblaar en skutblaartjie is min of meer ewe lank en grootliks wit en membraneus. Hulle is geslote in hul onderste helftes en omklem die vrugbeginsel en onderste helfte van die blomdekbuis. Die buitenste, die skutblaar, is skerp en het in sy top-helfte of top-kwart 'n smal groen mediane strokie; die binneste, die skutblaartjie, is dikwels uitgerand aan die top, besit twee groen lengtestrokies en is soms tweekielig—wat mag aandui dat dit uit twee vergroeide profile ontstaan het. Behalwe vir die hoogte wat hulle teen die blomdekbuis bereik, toon die skutblaar en skutblaartjie geen kenmerke van belang om die spesies uit te ken nie.

By die meeste droë eksemplare en sommige vars eksemplare is die membraneuse gedeeltes van die skutblaar en skutblaartjie fyngestreep, met bruin tannien-bevattende idioblaste wat enkeld of in kort selrye lê. Selfs in gevalle waar bruin strepies afwesig is, kon kleurlose tannien-idioblaste ook aangetoon word met 'n kafeïenoplossing.

Volgens Lewis (1954) en Burt (1970) verskil *Syringodea* van *Romulea* daarin dat die blomme kort gepediselleer is bo die twee-kleppige bloeiskede. 'n Ware pedisel is egter nie gevind nie: wanneer die vrug ontwikkel, bly die basis van die vrugbeginsel dikwels (behalwe by *S. unifolia*) smal omdat dáár geen sade ontwikkel nie. Hierdie smal vrugbasis lyk na 'n pedisel, maar 'n dwarsnee daardeur toon duidelik die drie vrugbeginselhokke waaruit dit bestaan. Dit word hier 'n pseudo-pedisel genoem.

Die blom. Weens die kort pedunculi en die lang blomdekbuis (perigonium-buis) is die basisse van die blomme ondergronds verberg.

Die blomdekbuis is reguit, langer as die blomdeksegmente, smal-silindries en ongeveer 1 mm in deursnee, behalwe vir die boonste ongeveer 10 mm waar dit tregtervormig verbreed tot nagenoeg 2–3 mm in deursnee. Binne elke spesie kom variasie voor in die lengte van die blomdekbuis en die lengte en breedte van die segmente, sodat die blomdek min kenmerke toon wat van diagnostiese belang is. *S. pulchella* egter word uitgeken aan sy diep uitgerande blomdeksegmente. By al die ander spesies varieer die segmente dikwels van skerp tot stomp, sodat hierdie kenmerk nie van diagnostiese waarde is nie.

Die blomdekkleur verskil van helder blou of helder violet tot ligblou, ligpers en soms wit. Binne sommige spesies is daar kleurvariasie: by bv. *S. longituba* is die keel oranjegeel, helder geel, wit of pers, en by *S. derustensis* kom wit blomme soms voor tussen die oorweënde ligviolet blomme. Die kleur van vars

blomme word by die spesies-beskrywings ook aangegee volgens die kleurkaart van die Royal Horticultural Society (1966) as 'n RHS-nommer.

Die blomme open vir twee tot vier dae lank elke oggend met temperatuurstyging, en sluit weer saans. In die nag wat antese voorafgaan verleng die blomdek vinnig tot ongeveer dubbeld sy vorige lengte. By *S. concolor* groei die blomdebuis 25 mm langer tussen die eerste en tweede dag van antese.

Sommige, bv. *S. pulchella*, open reeds vroeg in die voormiddag by 'n betreklik lae temperatuur, en word trompetvormig met horisontaal-spreidende segmente. Die blomme van ander spesies open by hierdie temperatuur slegs tot 'n tregtervormige fatsoen, soos Baker (1876a) aangetoon het vir *S. bicolor* en *S. filifolia*. Hierop het Baker (1896) die genus in twee subgenera ingedeel volgens die vorm van die oop blom. Hierdie indeling kan egter nie aanvaar word nie, aangesien die blomme van die meeste spesies trompetvormig word wanneer die temperatuur verder styg, soos dit normaal in hul natuurlike habitats in Suid-Afrika gebeur. Trouens, by nog hoër temperature raak die blomdeksegmente by al die spesies selfs teruggekrom.

Die meeldrade toon, behalwe soms vir hul kleur, geen diagnostiese kenmerke om die spesies te onderskei nie. Hulle is regop of effens spreidend, met die toppe van die helmknoppe soms ingebuig; hulle is ingeplant in die keel van die blomdek, staan simmetries rondom die styl, en is uitgestoot behalwe vir sommige eksemplare van *S. longituba* (bv. *de Vos* 2271) waar slegs die helmknoppe uitgestoot is. Die helmdrade is dun, naak en gegroef aan die binnekant, meestal wit, soms geel of pers. Die goudgeel pollen gee aan die helmknoppe 'n geel kleur. Die korrels is koeëlvormig en nie-aperturaat, met 'n spinulae-draende, skynbaar nie-punktate tegillum (Fig. 2). By die tipiese subgenus is die korrels van 44–50 μm vir *S. longituba* tot 54–60 μm vir *S. pulchella* in deursnee en die spinulae eweredig versprei. By subgenus *Rhipidopsis* is hulle 60–62 μm in deursnee en het hulle drie kringe waarop minder spinulae voorkom. Of die lg. ooreenstem met die spiraperturate pollen van sekere *Crocus*-spesies (Erdtman, 1952; Schulze, 1971) is onseker. *Syringodea* se pollen verskil dus van *Romulea* s'n, wat 1-sulkaat is en 'n punktitegillate eksien het. Volgens Schulze is die *Syringodea*-pollen tog moontlik afgelei van 'n *Romulea*-agtige pollentipe.

Die vrugbeginsel toon geen kenmerke waardeur spesies uitgeken kan word nie.

Nektar word, soos in die geval van *Romulea* en ander Iridaceae, in septale nektarkliere geproduseer in die top van die vrugbeginsel waar die septa breed is. Dit word in die basis van die blomdebuis uitgestort en styg met kapillariteit op in die smal buis, sodat selfs insekte met kort suigorgane nektar kan bekom en bestuiwing teweeg bring.

Die styl is baie dun en filiform, langer as die blomdebuis, en die top is uitgestoot. Dit is regop en sentries, behalwe by *S. unifolia* waar die styltop by

ouer blomme eksentries mag buig. Die drie gekromde styltakke staan teenoor die meeldrade, maar draai dikwels effens om by die meeldrade verby te steek. Die takke, wat lang stempels vorm, is baie korter as die styl, is gekondupliseer of van bo gegroef, met papillae op die rande. Die stempelpunte is dikwels breër en spateïvormig, met 'n ry langerige papillae om die rand. By *S. unifolia* is die stempels veeldelig en herinner aan *Crocus*, of lyk hulle soms uitgerafel aan die toppe. By *S. derustensis* kom ook soms 'n effense vertakking aan die toppe

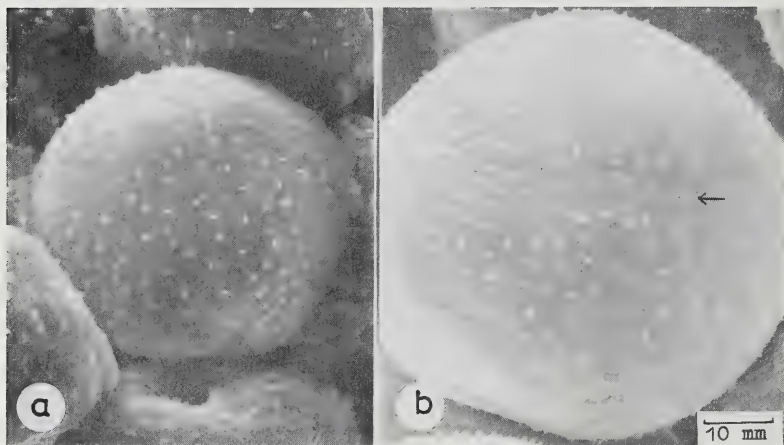


FIG. 2.

Skandeer-elektronmikrofoto's van *Syringodea*-stuifmeel (beskadu met koolstof en goud, sonder asetolise): a, *S. longituba*; b, *S. unifolia*: Pyl toon 'n baan met minder spinulae.

voor. Waar die stempels onverdeel is, splits die xileem van elke stempel aan die top onreëlmatig in verskeie kort takkies. Die veeldelige stempels van *S. unifolia* is dus slegs 'n verdere verdeling, ook van die stempelweefsel.

Die doosvrug. Die vrugwand van die lang- of kort-tolvormige of soms ellipsoïede doosvrug is membraneus-horingagtig, met 'n gelignifiseerde endokarp (die binne-epidermis). Die uitgedroogde eksokarp toon meestal dwarsrimpels, behalwe by die subgenus *Rhipidopsis*. Slegs die top van die doosvrug verskyn bo die grond, deur die verlenging, nie van die vrugsteel of stingel nie, maar van die vrug self. Die basis van die vrug is dikwels sonder sade en bly smal om 'n pseudo-pedisel te vorm.

By die subgenus *Syringodea* is die vrug hicrochasties en hok- en skotspletig, met ses kleppe. Die droë vrug splits, nadat dit nat gemaak is, meestal binne 'n paar minute oop in sy top-kwart tot helfte. Die ses vrugblaar-vaatbundels

splits af van die kleppe, en die septa tussen die vrughokke is baie dun en vergaan. Vrugte waarin min sade ontwikkel het, splits dikwels eers oop na verskeie male se nat- en droogwording. Met droogwording sluit die vrug weer gedeeltelik. Hierdie klepbewegings vind herhaaldelik plaas by natwording en uitdroging. Die vrugte van sommige spesies, bv. *S. longituba*, is sterk hicrochasties en die ses kleppe buig terug (Fig. 14) soos Stopp (1958) beskryf het vir *S. leipoldtii*; by ander, bv. *S. pulchella*, gaan staan die kleppe orent (Fig. 11). Hier skyn dit asof die mesokarp en eksokarp, wat dikker is as by *S. longituba*, 'n weerstand teen die terugbuiging bied.

By die subgenus *Rhipidopsis* is die vrugte xerochasties. Hulle is hokspletig met drie kleppe en bly permanent oop. Die septa tussen die vrughokke is dik en blywend (Fig. 17).

Die talryke sade, hoekig gedruk tot byna bolrond en gedra op asstandige plasentas, is meestal 1–1,5 mm in deursnee. Die ornamentasie van die testa verskil by die verskeie spesiesgroepe. Hulle kan retikulaat, retikulaat-foveaat, foveaat (gepunt) of kollikulaat (geknobbel) wees (Fig. 7). By *S. bicolor* en *S. pulchella* is die saadhuid retikulaat-foveaat met 5–6 interstitia per millimeter. By die ander spesies van die seksie *Syringodea* is die interstitia kleiner. By die seksie *Saxatiles* is die saadhuid fyn kollikulaat of soms fyn foveaat waar die sade styf teenmekaar gedruk lê. By die subgenus *Rhipidopsis* is die testa gekreukeld-retikulaat (Fig. 7f).

ANATOMIESE ONDERSOEK

Om 'n grondige insig te kry in die morfologiese verskille wat by die knoltunicae, die blare, die saadhuide en die vrugwande van die *Syringodea*-spesies voorkom, is hierdie strukture anatomies ondersoek.

Materiaal en metodes. Vars materiaal van al die spesies, behalwe *S. flanaganii*, is uit hul natuurlike habitats versamel en na die Plantkunde-departement, Universiteit van Stellenbosch, oorgeplant om te bestudeer.

Die knoltunicae en saadhuide is besonder hard, en vriesmikrotroomsneë het die beste resultate opgelewer. Die seksies, 20 μ m dik, is met verskillende histo-chemiese reagentie behandel om die selwandstowwe en selinhoud te bepaal. Ander is met saffranien gekleur en op die gewone manier permanent gemaak. Jeffrey se maserasiemetode, gevolg deur kleuring met saffranien, is gebruik om die sklereïede van die knoltunicae te ondersoek.

Die vrugwande is met die vriesmikrotroom gesny, asook met die rotasie-mikrotroom, na infiltrasie en inbed in paraffienwas. Die blare is met die rotasie-mikrotroom gesny; maar omdat die groot styloïede die sneë laat skeur, is daar ook van vryhand-seksie gebruik gemaak. Verder is dik sneë met fosfomolibdeensuur-asynsuur-formalinen behandel (Dugdale, 1971) om die verspreiding van die tannien-bevattende idioblaste te vind.

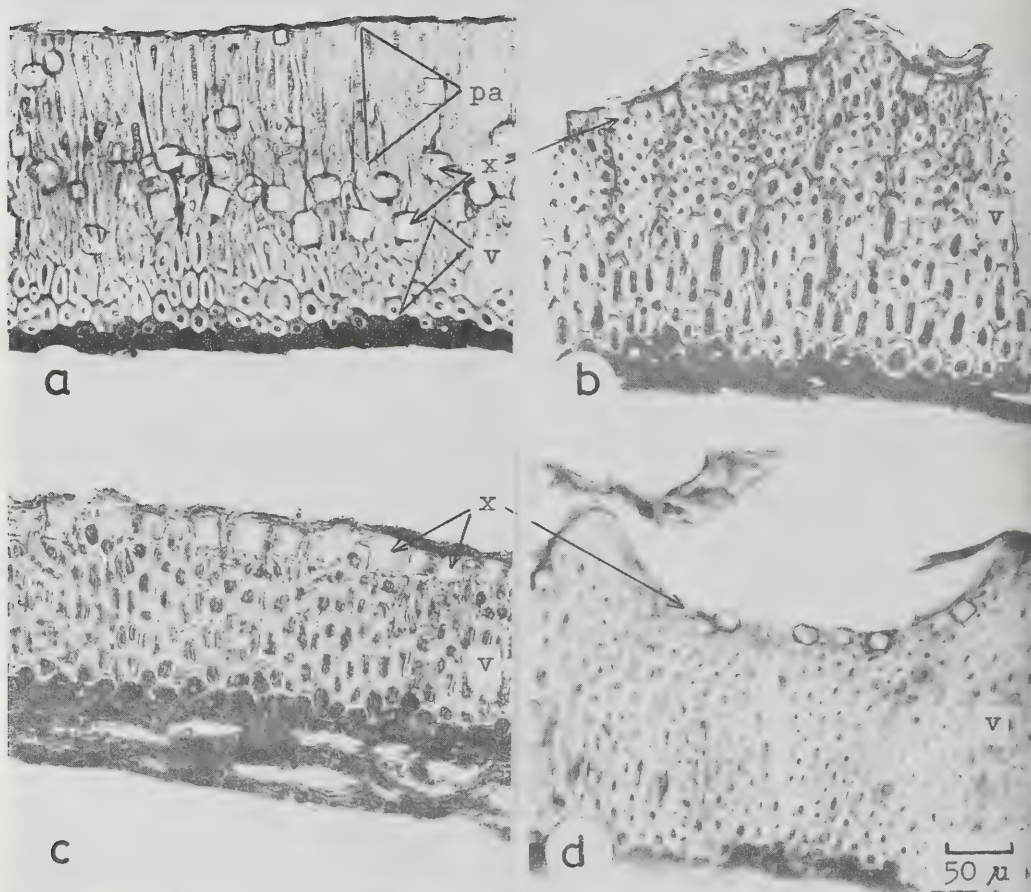


FIG. 3.

Dwarssneë deur die knoltunicae van *Syringodea*-spesies, met die vriesmikrotoom gesny: a, *S. bicolor*; b, *S. longituba*; c, *S. saxatilis*; d, *S. derustensis*; pa, palissade-agtige sklereïede; v, vesels; x, kristalle.

Die knoltunicae. By al die spesies het die harde, verhoue knoltunicae 'n algemene struktuur soos volg: Die epidermisselle aan die binnekant (adaksiale kant) van die tunica, asook die aangrensende sellae is groot en betreklik dunwandig en word uiteindelik grootliks platgedruk. Die vaatbundels is in hierdie laag geleë en word ook saam daarmee geöbliteer. Hierop volg 'n digte sone sklerenchiem met dik, verhoue selwande, smal lumina en stippelkanale. Meestal kom dunwandige idioblaste verspreid hierin voor, elk met één kristal van kalsiumoksalaat. Die sklerenchiemlaag wissel in dikte en bepaal die dikte van die tunica. Aangrensend aan die sklerenchiemlaag lê die die buitenste (abaksiale) epidermis, van groot, betreklik dunwandige selle wat vergaan en afskilfer. Die selle is nie veel langer as breed nie, en hul buitelyne (d.w.s. antiklinale wande se merke) is uitwendig op die tunica sigbaar met die hulp van 'n lens wat 20-maal vergroot. Naby die basale rif van die knol lê daar verskeie lae sagte parenchiem wat ook vergaan, tussen die epidermis en die sklerenchiemweefsel.

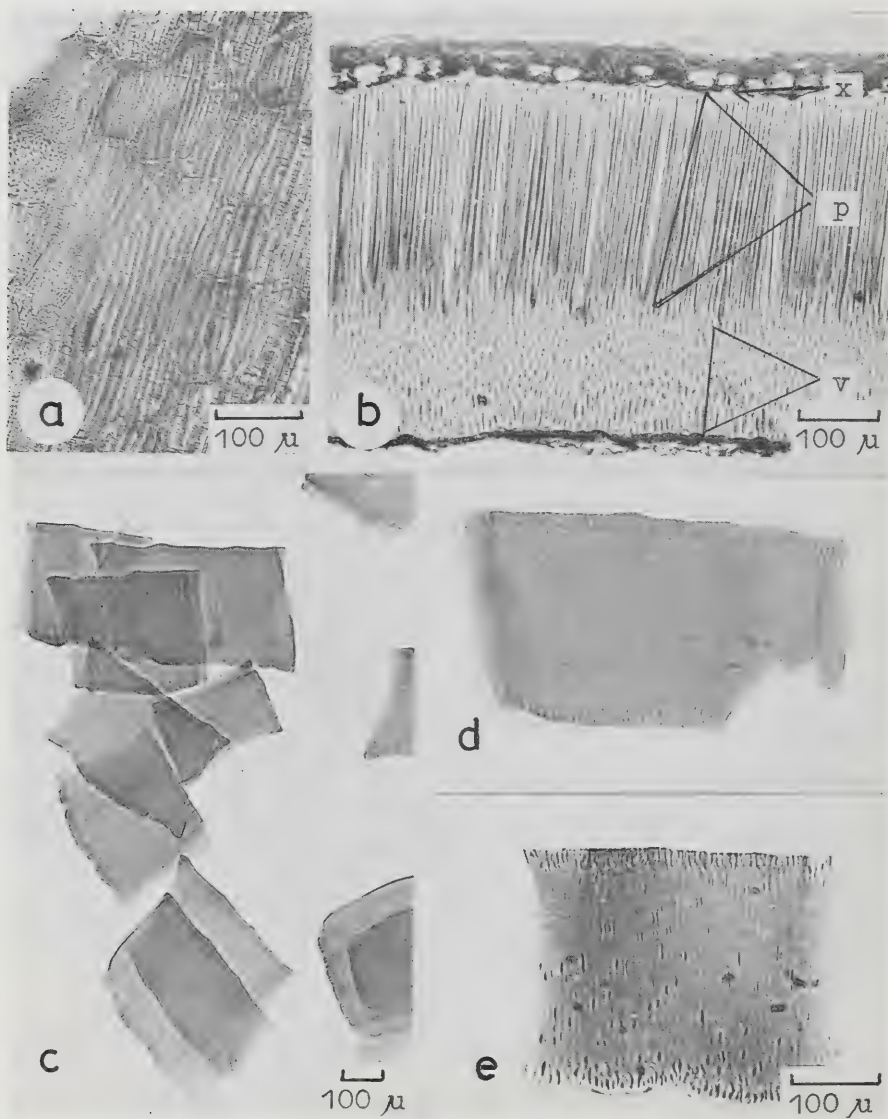
Die bogenoemde sklerenchiem is die belangrikste weefsel van die harde tunica. Dit varieer in struktuur en bied 'n goeie diagnostiese kenmerk aan vir die uitkenning van die twee subgenera en die twee seksies.

By die subgenus *Syringodea* kom twee tipes sklerenchiem voor:

1. By die seksie *Saxatiles* bestaan dit uit 'n massa verlengde veselagtige sklerenchiem, min of meer parallel met die lengte-as van die tunica gerangskik (Fig. 3b-d). Stippels is min en onreëlmatig versprei in die veselwande. Getoets met floriglusion, lyk die selwande onegalig gelignifiseer: die ouer selwandlae bevat meer lignien as die jonger lae, en by *S. derustensis* is ook die jongste wandlagie teen die lumen meer verhout as die middellae.

Kristal-idioblaste kom in onegalige groepies voor in die laag aangrensend aan die abaksiale epidermis, met die kristalle ewe hoog teen die epidermis geleë. Plek-plek is die kristalle afwesig en hier vorm die sklerenchiemselle soms opgehewe bultjies (Fig. 3b, d) wat 'n skurwe oppervlakte aan die tunica gee (*S. derustensis* Fig. 1e, en ook sommige *S. longituba*, soos bv. die tipe-eksemplare). Die kristalle is of isodiametries (bv. *S. derustensis*), of verleng (50–70 μm by 10–16 μm , bv. *S. saxatilis*). By *S. longituba* varieer die kristalle van isodiametries by sommige kolleksies tot verleng by ander (o.a. die tipe-eksemplare). Sover vasgestel kon word, kom verlengde kristalle saam met ruwe tunica-oppervlaktes by hierdie spesie voor, en isodiametriese kristalle saam met gladde tunicas.

2. By die seksie *Syringodea* is die sklerenchiemlaag in twee sones gedifferensieer. Teenaan die abaksiale epidermis is palissade-agtige sklereëde met die selle tot 'n mindere of meerdere mate verleng en reghoekig op die epidermis geleë (Fig 3a). Die kristal-idioblaste is op verskillende dieptes in die laag ingebed, met die meeste idioblaste diep geleë. Die kristalle is isodiametries, lyk



naasteby kubiek en is 8–10 μm in deursnee. Die hoogte van die palissadeagtige sklerenchiemlaag wissel met die dikte van die tunica. Onder die palissade-laag kom 'n laag sklerenchiemvesels voor, parallel met die lengte-as van die tunica geplaas, net soos die sklerenchiemlaag by die seksie *Saxatiles*. Anders as by die laaggenoemde, besit die sklerenchiemselle hier talryke, eweredig verspreide stippels en die selwande is egalig verhoud.

By die subgenus *Rhipidopsis* is die sklerenchiemlaag ook in twee sones gedifferensieer. Die dieper laag stem ooreen met die diep sklerenchiemlaag van seksie *Syringodea*. Die laag teen die abaksiale epidermis is egter heeltemal verskillend en is gespesialiseerd. Dit bestaan uit plat sklerenchiemplaatjies (Fig. 4), wat parallel met mekaar, reghoekig op die epidermis en parallel met die lengte-as van die tunica geplaas is. Elke plaatjie, wat één sklereïed voorstel, is 110–180 μm hoog, afhangende van die dikte van die tunica, 160–300 μm lank en slegs 8–10 μm dik. Meeste is reghoekig van vorm (Fig. 4c, e); sommige het onreëlmatige onderste periklinale rande (Fig. 4d). Hul selwande is sterk verhoud en baie dik, sodat die lumina meestal minder as 0,5 μm breed is. Aan hul bo- en onderrande wat respektiewelik teen die abaksiale epidermis en die dieper sklerenchiemlaag grens, kom talryke stippels voor. Op hul plat (antiklinale) kante is die stippels min en spleetvormig.

In 'n dwarssnee deur die tunica lyk die plaatjies palissade-agtig (Fig. 4b). Hier en daar kom 'n breër plaatjie voor met 'n spierwit lumen wat tot 6 μm breed en waarskynlik leeg is. In 'n paradermale snee lyk die plaatjies na sklerenchiemvesels met taamlike skerp, oorvleuelende eindes (Fig. 4a). In 'n lengtesnee deur die tunica is die oppervlakte van die plaatjies te sien. Dit geluk egter selde om parallel met 'n plaatjie te sny en daarom is die weefsel gemasereer om 'n geheelbeeld van die plaatjies te kry (Fig. 4c–e).

Soortgelyke sklereïedvorme kon nie in die anatomiese literatuur opgespoor word nie. Ek stel voor om hulle *platysklereïede* te noem.

By hierdie subgenus is kristalle seldsaam in die tunicae en kom hulle slegs naby die waaivormige rif, tussen die platysklereïede en die sagte weefsel voor wat hier (naby die rif) uit die epidermis asook uit verskeie lae geëblitereerde parenchium bestaan (Fig. 4b).

Die loofblaar. Die stomata is sonder hulpselle en is eweredig versprei in elke epidermale selry behalwe in die adaksiale groef. 'n Stoma en 'n gewone epidermissel, of soms twee, wissel mekaar reëlmatig af. Die epidermisselwande,

FIG. 4.

Die knoltunica van *S. unifolia*: a, buitenste (abaksiale) oppervlakte, met epidermisselle bo-oor die platysklereïedlaag; b, dwarssnee deur 'n tunica: p, platysklereïede; v, vesels; x, kristalle; c, platysklereïede in 'n gemasereerde preparaat; d, 'n uitsonderlike vorm van 'n platysklereïede; e, gewone vorm van platysklereïede.

veral die buitenste en die binne-periklinale wande, is verdik, maar die kutikula is dun.

Die blaarrande is by die meeste spesies dikwels gesilieerd met 'n ry eensellige dikwandige epidermale trichome. Hulle toon waar die adaksiale en abaksiale kante van die blaar teen mekaar stoot.

Onder beide adaksiale en abaksiale epidermis kom twee tot drie sellae groen palissade voor, behalwe in die adaksiale groef van breë blare—vandaar die liggroen mediane strepie wat by die seksie *Syringodea* uitwendig te sien is. Sentraal van die palissade bestaan die mesofil uit ronde parenchiemselle met min chloroplaste en klein intersellulêre ruimtes. By breë blare is die sentrale mesofilselle baie groot, nagenoeg kleurloos en soms vervorm of verskeur. Kenmerkend vir die subgenus *Syringodea* is die groot tannien-bevattende idioblaste wat in groter of kleiner getalle in die mesofil, veral in die omgewing van die vaatbundels, aanwesig is (Fig. 5a).

Meestal lê die vaatbundels diep in die mesofil, aan die basis van die palissade of in die sentrale rondsellige gedeelte. Die aantal vaatbundels varieer met die blaarbreedte: smal filiforme blare het meestal vyf of soms tot nege vaatbundels (*S. longituba*), en breë blare agt tot baie (*S. pulchella*, *S. bicolor*, *S. derustensis*, *S. unifolia*). Meestal is daar twee groot hoof-laterale bundels, elk met 'n groot sklerenchiemskede aan hul ad- en abaksiale kante. Die mediane bundels, wat soms weg van die mediane lyn lê, is kleiner as die hoof-laterale bundels. Die ventrale bundels in die blaarrande is besonder klein. 'n Uitsondering van die bogenoemde is by sommige eksemplare van *S. longituba* (bv. *de Vos* 2266) gevind, waar 'n enkele groot, byna mediane bundel en vier kleiner bundels voorkom (Fig. 14g).

Soos by *Romulea*, is lang styloïede van kalsiumoksalaat-monohidraat aanwesig, veral in die vaatbundelskeds en soms ook versprei in die mesofil.

Behalwe vir die twee reeds genoemde verskille tussen die blare van *Syringodea* en *Romulea*, t.w. die grotendeels bifasiale vorm en die afwesigheid van vier lengtegroewe by die e.g., verskil die *Syringodea*-blaar van *Romulea* meestal ook in die eweredige verspreiding van die stomata en die aanwesigheid van tannien-bevattende idioblaste.

Net soos die knol van die subgenus *Rhipidopsis* uniek is vir die genus, toon die blaar van dié subgenus ook uitsonderlike kenmerke: die vier groot vaatbundels (hoof-laterale en ventrale) lê vlak en is van die abaksiale epidermis geskei deur een laag grootsellige kleurlose, radiaalgestrekte parenchiemselle (Fig. 5b, 17e). In hierdie kostale stroke is stomata afwesig. In die adaksiale groef kom 'n massa kleurlose kollenchiem subepidermaal voor. Tannien-idioblaste is afwesig.

Die vrugwand. In 'n poging om die meganisme te vind wat verantwoordelik is vir die higrochasje by die subgenus *Syringodea* en die xerochasje by die sub-

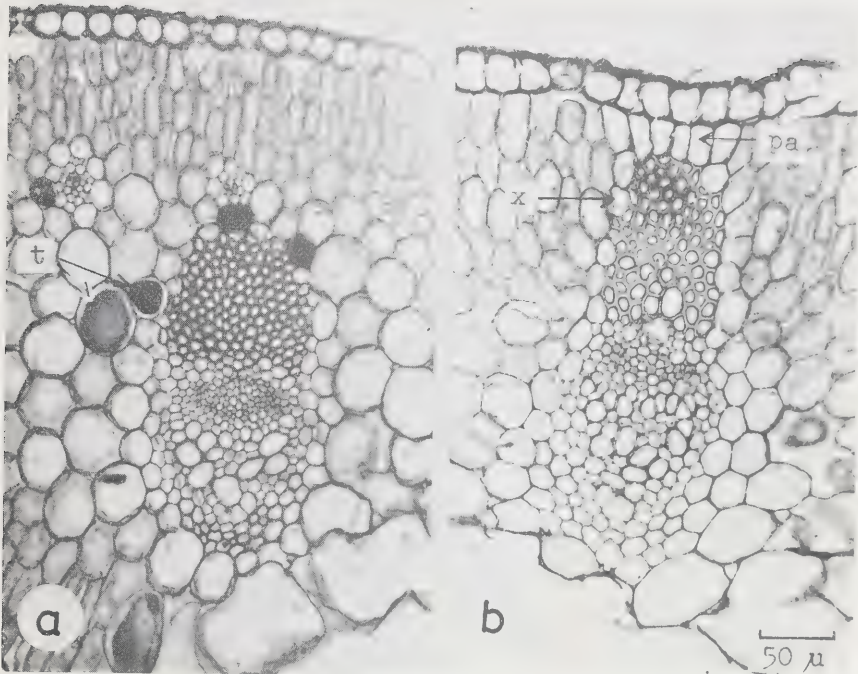


FIG. 5.

Dwarsnede deur die hoof-laterale vaatbundels van die blare van a, *Syringodea pulchella*, en b, *S. unifolia*: t, tannienbevattende idioblaste; pa, kleurlose subepidermale parenchium; x, kristalle.

genus *Rhipidopsis*, is snede deur die vrugwand van *S. pulchella*, *S. longituba*, (subgenus *Syringodea*) en *S. unifolia* (subgenus *Rhipidopsis*) gemaak (Fig. 6). Hieruit blyk dat die anatomiese struktuur van die vrugkleppe by die twee subgenera basies ooreenstem.

Die eksokarp en endokarp bestaan uit die buite-epidermis en binne-epidermis van die vrugwand onderskeidelik. Die eksokarpselle is parallel met die lengte-as van die vrug gestrek; die endokarpselle daarenteen reghoekig op die vrug se lengte-as. Die eksokarp, asook die mesokarp, bestaan uit groot onverhoude selle wat opdroog en grotendeels ten gronde gaan. Die kutikula van die eksokarp bly egter behoue. In die mesokarp kom groot tannien-bevattende idioblaste verspreid voor (Fig. 6).

Die endokarpselle wat in die dwarste van die vrug gestrek is, is agt- tot

twaaftmaal langer as breed, asook twee- tot viermaal hoër (in die radiale rigting) as breed. Hul periklinale wande wat aan die vrughokke grens, is uitermate verdik en gelignifiseerd. In die selwandlae naby hul lumina kom daar, behalwe die lignien, ook selwandstof voor wat helder-rooi gekleur word met rutenium-rooi en waarskynlik pektiese verbindings is.

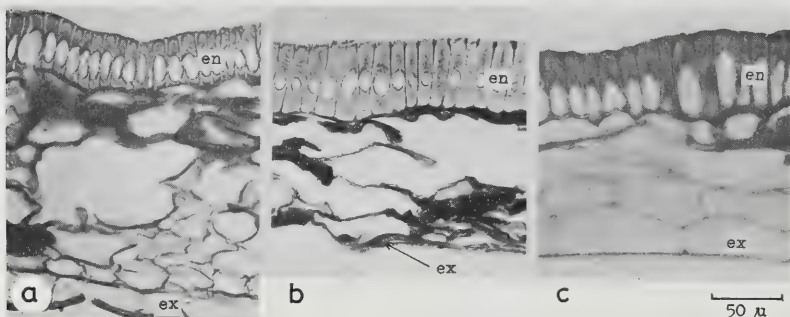


FIG. 6.

Lengtesnee deur die perikarp van *Syringodea*-spesies, met 'n vriesmikrotoom gesny: a, *S. pulchella*; b, *S. longituba*; c, *S. unifolia*; en, dikwandige endokarp; ex, eksokarp.

Die grootte van die endokarselle en die dikte van hul selwande verskil by die twee subgenera. By die twee ondersoekte voorbeelde van die subgenus *Syringodea* is die endokarselle, soos gesien in 'n lengtesnee deur die klep, 8–15 μm breed, en ongeveer drie- tot viermaal hoër (radiaal) as breed, met reghoekige buitelyne. Beide die buite- en binne-periklinale selwande is verdik, met die wand wat aan die vrughok grens die dikste. Die antiklinale wande is dun. Die sellumina is rond of ovaal in deursnee en baie smal (Fig. 6a, b). Stippels is min. By *S. pulchella* bly die mesokarp en eksokarp langer behoue as by *S. longituba*, en lyk die vrugwand dus breër.

By *S. unifolia* van die subgenus *Rhipidopsis* is die endokarselle 18–30 μm breed, d.w.s. nagenoeg dubbeld so breed as by die subgenus *Syringodea*. Hulle is slegs twee- tot driemaal hoër as breed. Die periklinale wande wat aan die vrughokke grens is verdik, maar die ander selwande is betreklik dun en besit baie stippels. Die lumina is dikwels effens hoekig (Fig. 6c) en is groter as by die vorige. As 'n mens die graad van lignifikasie mag beoordeel volgens die duur van die floriglusien-kleuring, dan is die endokarselwande van *S. unifolia* meer verhout as by die voorbeelde van subgenus *Syringodea*.

In eksperimente uitgevoer met afgesnyde vrugkleppe van *S. pulchella* en *S. longituba*, krul die klep binne twee sekondes ná natwording vinnig na binne, en strek dan stadig reguit of buig effens na buite. Die endokarp alleen, nadat

die mesokarp en eksokarp verwyder is, voer dieselfde bewegings uit; dit toon dat die bewegingsmeganisme in die endokarp geleë is. Die kleppe van *S. unifolia* toon nie hierdie reaksies nie.

Die waargenome verskille in die anatomiese bou van die endokarp by die twee subgenera lyk skaars voldoende te wees om die hicrochase en xerochase te verklaar. Miskien lê die antwoord ook deels in die hoeveelheide en verspreiding van selwandstowwe soos pektien wat in water opswel, en lignien wat moontlik weerstand bied teen opswel, of in die oriëntasie van die mikrofibrille van die endokarp-selwande.

Die saad. Sneë deur die sade is ondersoek om die anatomiese verskille van die verskillende ornamentasiepatrone van die testa te vind. Soos by ander Iridaceae (Netolitsky, 1926), besit die ryp saad van *Syringodea* 'n harde, digte, horingagtige endospermweefsel wat olie en aleuron stoor, asook hemisellulose in die sterk verdikte selwande. Die nucellus is heeltemal geresorbeer en die endosperm lê styf teen die binne-integument (Fig. 8a). Die embrio lê effens los in die endosperm.

Die saadhuid word gevorm uit beide integumente. Daar is drie kutikulalae: buitekant die buite-integument, tussen die twee integumente, en tussen die binne-integument en die endosperm. Van die twee sellae van die binne-integument bly die binnelaag behoue en die ander word platgedruk. Van die buite-integument bly slegs die buite-epidermis behoue, behalwe by die subgenus *Rhipidopsis* (Fig. 8).

Die struktuur van die testa verskil in details by die twee subgenera en die twee seksies van die genus: in dikte, in die lae wat verhout, en in die lae wat die verskillende patrone op die testa veroorsaak. Die foveate toestand, byvoorbeeld, word deur die binne-integument en die ongelyke endospermoppervlakte teweeggebring, en die kollikulate toestand deur die buitelaag van die testa.

By die subgenus *Syringodea* is die endospermoppervlakte dikwels ongelyk (Fig. 8a). Die retikulaat-foveate ornamentasiepatroon (Fig. 7a, c) van *S. pulchella* en *S. bicolor* (seksie *Syringodea*) word veroorsaak deur holtes in die oppervlakte van die endosperm wat waarskynlik daarin geper is deur die vergroting van die selle van die binne-integument. Teenaan elke holte lê één groot, taamlike plat binne-integumentsel (Fig. 8a) wat in die tangensiale rigting tot nagenoeg 200 μm gestrek is en in die radiale rigting slegs 40–50 μm breed is. Sy selwande is verdik maar is sonder lignien. Sy antiklinale selwande lê reg teenoor die opgehewe “muurtjies” van die endospermoppervlakte en die opgehewe “muurtjies” van die patroon op die testa. Die epidermisselle van die buite-integument is klein en lê egalig bo-oor die binne-integument. By *S. bicolor* het hierdie selle dik gelignifiseerde selwande wat die lumina byna toestop; by *S. pulchella* is hulle sonder lignien, maar die geöblitereerde sellae van die buite-integument is gelignifiseerd.

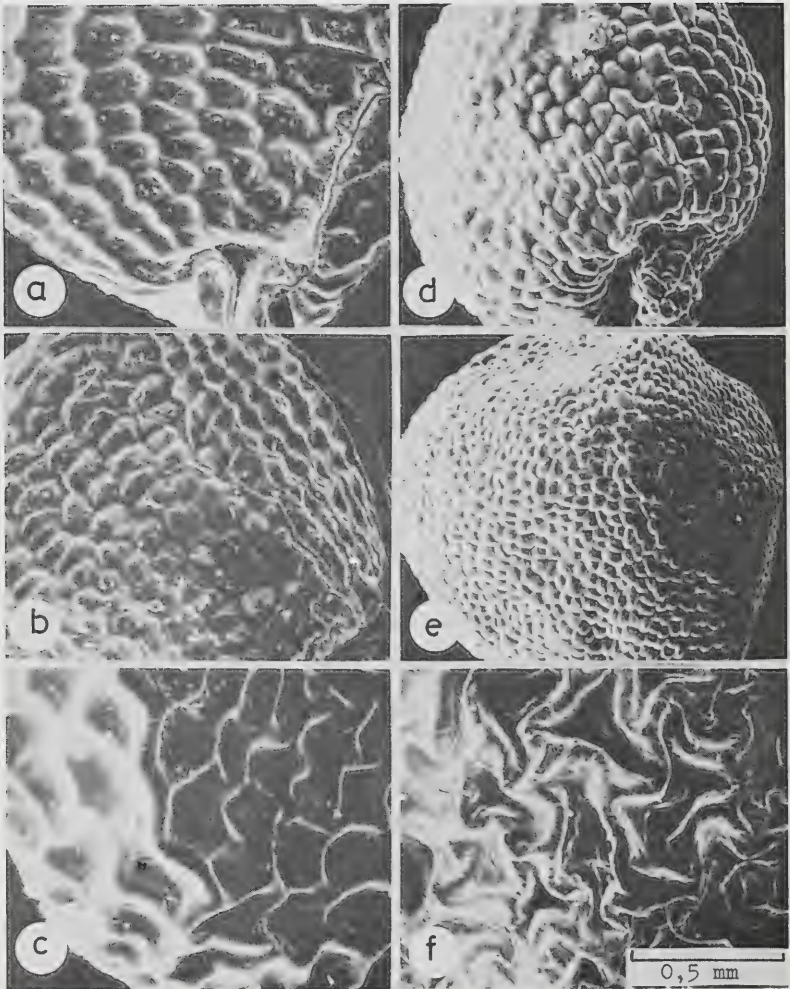


FIG. 7.

Skandeer-elektron-mikrofoto's van die saadhuide van *Syringodea*-spesies (beskadu met koolstof en goud): a, *S. pulchella*; b, *S. concolor*; c, *S. bicolor*; d, *S. longituba*; e, *S. derustensis*; f, *S. unifolia*.

Die kollikulate ornamentasie (Fig. 7d, e) wat dikwels by die seksie *Saxatiles* voorkom, word veroorsaak deur bolvormige uitbultings van die epidermisselle van die buite-integument, elke knobbel deur één epidermissel teweeg gebring (Fig. 8b). By *S. saxatilis* is hierdie selle gelignifiseerd onder 'n dun kutikula en die sellumen bevat olie; by *S. derustensis* bevat die selwande suberien asook lignien en die sellumina is byna geöblitereerd. Soms is die testa by hierdie seksie ook gedeeltelik foveolaat, veral waar die sade styf teen ander vasgedruk was.

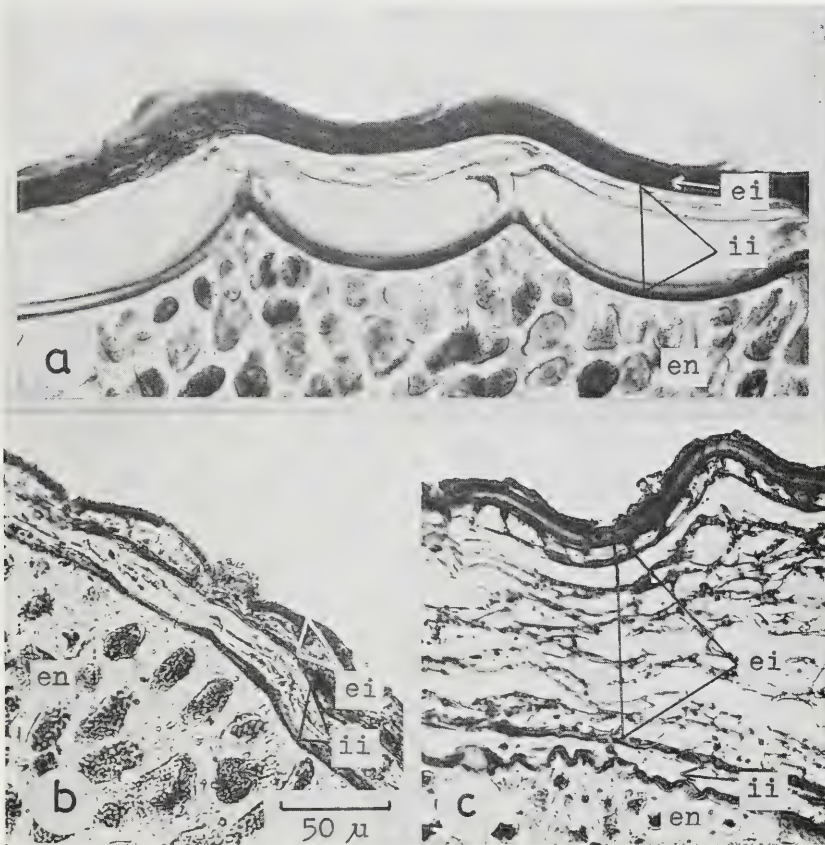


FIG. 8.

Sneeë deur die testa van *Syringodea*-spesies, met die vriesmikrotroom gesny: a, *S. bicolor*; b, *S. derustensis*; c, *S. unifolia*; ei buite-integument; en endosperm; ii, binne-integument.

Dit word veroorsaak deur induikings van die bg. epidermisselle, of soms ook, soos by seksie Syringodea, deur groot selle van die binne-integument. Die endospermoppervlakte hier is òf glad òf ongelyk.

Die subgenus *Rhipidopsis* (*S. unifolia*) verskil in sy dikker testa met 'n onreëlmatige gerimpeld-geretikuleerde patroon daarop (Fig. 7f) en in 'n gladde endospermoppervlakte. Die buite-integument is breed en bestaan uit die buite-epidermis van klein reëlmatige selle met verhoude buitewande onder 'n dik kutikulalaag, en verskeie lae groot dunwandige, min of meer leë, taamlik platgedrukte en deels verskeurde parenchiemselle (Fig. 8c). Tydens die saad-ontwikkeling vermeerder die epidermisselle so baie dat hulle nie meer plat op die weefsel daaronder kan lê nie. Hulle, en die aangrensende laag van groot selle, word tot riwwe opgehewe en vorm die retikulate patroon op die testa. Die enkele oorblywende laag selle van die binne-integument is klein, isodiametries, effens verhout, en lyk leeg.

Bespreking en opsumming. Die anatomiese ondersoek toon dat *S. unifolia* ook anatomies van die ander spesies verskil, hoofsaaklik in: (1) die aanwesigheid van 'n subepidermale laag platysklereïede in die knoltunicae; (2) in die blaar die aanwesigheid van kleurlose parenchium teenoor die vier vlak vaattubels en kollenchium in die adaksiale groef, en die afwesigheid van tannienhoudende idioblaste; (3) die dikker testa met 'n dikker buite-integument van meer as een sell laag en 'n gerimpeld-retikulate ornamentasiepatroon wat veroorsaak is deur 'n proliferasie van die buitenste selle; en (4) die breër, blywende septa tussen die vrughokke. Die plasing van *S. unifolia* in 'n eie subgenus word dus ook deur sy anatomiese bou ondersteun.

Die anatomiese ondersoek toon verder dat die sewe spesies van die subgenus *Syringodea* in twee groepe ressorteer wat hoofsaaklik soos volg verskil:

Seksie *Syringodea*: (1) Die knoltunicae het 'n palissade-agtige subepidermale sklerenchiemlaag met baie stippels in die selwande en met kristal-idioblaste op verskillende dieptes geleë. (2) Die retikulaat-foveate ornamentasiepatroon op die testa word teweeg gebring deur holtes in die oppervlakte van die endospermweefsel, en die laag blywende binne-integumentselle.

Seksie *Saxatiles*: (1) Die subepidermale sklerenchiem van die knoltunicae is nie palissade-agtig nie, maar bestaan uit verlengde veselagtige selle wat parallel met die lengte-as van die tunica geplaas is en min stippels het; kristal-idioblaste is vlak subepidermaal geleë en kom in groepies voor; soms kom uitbultings van sklerenchiem voor op plekke waar kristalle afwesig is, om 'n ruwe oppervlakte aan die tunica te gee. (2) Die kollikulate testapatroon word veroorsaak deur eensellige uitbultings van die epidermis van die testa; 'n fyn foveate patroon wat soms aanwesig is, is hoofsaaklik te wyte aan ingedrukte epidermisselle.

CHROMOSOOMONDERSOEK

Die chromosome van slegs drie *Syringodea*-spesies is voorheen ondersoek (Goldblatt, 1971a), t.w. van *S. unifolia*, *S. bicolor* (*S. longituba* genoem) en *S. longituba* (*S. montana* genoem).

Metode. Vir die huidige ondersoek is knolle wat die vorige jaar versamel is, gedurende Februarie en Maart op nat sand geplaas tot die wortels te voorskyn kom. Na 'n voorbehandeling van drie uur in 'n versadigde paradichlorobensien-oplossing is wortelpunte gefikseer met ysasyn-etanol 1:3 vir 5 minute en tot die volgende dag gebêre in 70% etanol. Platpers-preparate is daarvan gemaak, na maserasie in 1/N HCl teen 60°C vir 8 minute en kleuring met lakto-propioonorseïen (Dyer, 1963). Die beste preparate is permanent gemaak in euparal. Die gebruikte knolle is geplant tot hul blomtyd, om herbariumeksemplare te maak wat in die Stellenbosch-tak van die Nasionale Herbarium (STE) bewaar word. Tekeninge van die metafase-chromosome is met die hulp van 'n camera lucida gemaak met 'n 4 000-maal vergroting (Fig. 9).

Resultate. Die chromosoomgetalle van al die *Syringodea*-spesies behalwe *S. flanaganii* is ondersoek (Tabel 1). Uit die tabel blyk dat die afsondering van *S. unifolia* in 'n eie subgenus ook deur sy afwykende chromosoomgetal geregverdig word, en dat die ses ondersoekte spesies van die tipiese subgenus naby mekaar staan, met eenderse chromosoomgetalle. As aanvaar word dat hierdie subgenus die primitiewe spesies besit, sal die basiese chromosoomgetal vir die genus ses wees. Dan moet verder aangeneem word dat *S. unifolia* (subgenus *Rhipidopsis*) ontstaan het deur poliploidie gevolg deur 'n aneuploidiese verlies van een paar chromosome.

TABEL 1.
Chromosoomgetalle van *Syringodea*-spesies.

Spesie	Diploïede chromosoomgetal	Vindplek	Ondersoekte eksemplare en verwysings
<i>S. pulchella</i>	12	Hanover	<i>de Vos 2257B</i>
<i>S. concolor</i>	12	Richmond	<i>Malan STE 30369</i>
<i>S. bicolor</i>	12	?	<i>Barker 10642b</i>
<i>S. bicolor</i>	12	Albany	(Goldblatt 1971a as <i>S. longituba</i>)
<i>S. longituba</i>	12	Matjiesfontein	<i>de Vos 2266</i>
<i>S. longituba</i>	12	Clanwilliam	<i>de Vos 2268</i>
<i>S. longituba</i> var. <i>violacea</i>	12	Riversdale	<i>de Vos 2270</i>
<i>S. longituba</i>	12	Van Rhynsdorp	(Goldblatt 1971a as <i>S. montana</i>)
<i>S. derustensis</i>	12	De Rust	<i>de Vos 2269</i>
<i>S. saxatilis</i>	12	Ladismith	<i>de Vos 2264</i>
<i>S. unifolia</i>	22	Sutherland	<i>de Vos 2217</i>
<i>S. unifolia</i>	22	Sutherland	(Goldblatt 1971a)

Anders as wat Goldblatt (1971 a) aandui, is gevind dat die chromosome van 'n komplement in grootte verskil van ongeveer $2\ \mu\text{m}$ tot 5 of $6\ \mu\text{m}$ en dat verskeie chromosome submediane sentromere besit. By al die ondersoekte spesies van die subgenus *Syringodea* is daar twee pare groot chromosome, waarvan twee 'n satelliet het. Verder kom daar twee paar klein chromosome voor en is die ander van middelmatige grootte (Fig. 9). Hoewel die kariotipes van die verskillende



FIG. 9.

Chromosome van *Syringodea*-spesies: a, *S. pulchella*; b, *S. concolor*; c, *S. longituba* var. *longituba*; d, *S. longituba* var. *violacea*; e, *S. derustensis*; f, *S. saxatilis*; g, *S. unifolia*.

spesies van subgenus *Syringodea* effens in chromosoomgrootte verskil, is daar geen ooglopende verskille tussen die kariotipes van die twee seksies van hierdie subgenus nie. Die verskille in chromosoomgroottes wat in die figure aangetoon word, is waarskynlik groter as wat werklik die geval is, aangesien chromosome van selle wat diep in die wortel geleë is moontlik nie soveel verkort word deur die paradichlorobensien-voorbehandeling nie, as dié van selle wat vlak onder die wortlepidermis lê.

Die chromosome van *S. unifolia* (seksie Rhipidopsis) verskil van dié van subgenus *Syringodea* hoofsaaklik in getal. Weens die klein aantal metafaseplate wat ondersoek kon word, kon nie bepaal word hoe sy kariotipe verder van die ander verskil nie.

Wat die verband is tussen die chromosome van *Syringodea* en die twee ander genera van die Crocineae, t.w. *Romulea* en *Crocus*, is nie duidelik nie. *Crocus* het diploïede chromosoomgetalle wat wissel van ses tot ongeveer 46, en chromosoomgroottes wat wissel van ongeveer 6 tot 10 μm vir *C. graveolens* en van minder as 1 μm tot ongeveer 4 μm vir *C. iridiflorus* (Mather, 1932). *Romulea* se diploïede chromosoomgetalle wissel van 18 tot ongeveer 54 en die groottes van minder as 1 μm tot 2,5 μm . *Syringodea* se chromosome is dus ongeveer dubbeld so groot soos *Romulea* s'n—iets wat verwag kan word as die genus *Syringodea* deur 'n dalende aneuploidie ontstaan het.

GEOGRAFIESE VERSPREIDING (Fig. 10)

Syringodea is endemies in die Kaapprovinsie en kom voor tussen die oos-lengtegrade 18° 45' en 27° 30' en suid-breedtegrade ongeveer 26° 45' en 34° 30'. Die spesies is grotendeels gekonsentreer in die droë dele, t.w. die Groot-Karoo en Klein-Karoo, met uitlopers na Oos-Kaapland, die suidkusdistrikte en die westkusdistrik van Malmesbury en, volgens 'n ou opgawe, noord van die Oranjerivier. Dit is nie 'n element van die Kaapse flora nie en kom nie in die Kaapse Skiereiland of die naburige distrikte van Stellenbosch, Somerset-Wes en die Paarl voor nie; ook nie in Namakwaland nie. (Die een kolleksie uit Namakwaland het geblyk 'n *Hesperantha* te wees, en dié uit die Transvaal waarskynlik 'n nuwe genus.)

In die sentrale en oostelike Karoo-distrikte vanaf Hanover tot Somerset-Oos kom drie verwante spesies, *S. bicolor*, *S. concolor* en *S. pulchella* voor. Die eersgenoemde het die wydste verspreiding, vanaf die Vetrivier (noord van die Oranjerivier?) tot Albany en King William's Town in Oos-Kaapland. *S. concolor* se areaal is byna net so wyd, vanaf Prieska in die noorde tot Albany en Queenstown. *S. pulchella* het, sover bekend, 'n baie kleiner areaal vanaf Hanover tot Somerset-Oos. 'n Vierde verwant, *S. flanaganii*, is op twee plekke in die Oostelike Provinsie gevind naby die see, t.w. Port Elizabeth en Komgha.

Die polimorfe spesie *S. longituba* kom voor vanaf die westelike karoo-agtige distrikte tot in die Klein-Karoo by Oudtshoorn. Dit het ook versprei na die laerliggende streke onder die eerste bergreekse, by Malmesbury en in die suidelike kusdistrikte van Caledon tot Mosselbaai. Die twee nuut ontdekte spesies het, sover bekend, uitsers beperkte areale: *S. saxatilis* slegs op een koppie by Ladismith en *S. derustensis* op een koppie naby De Rust, beide in die Klein-Karoo.

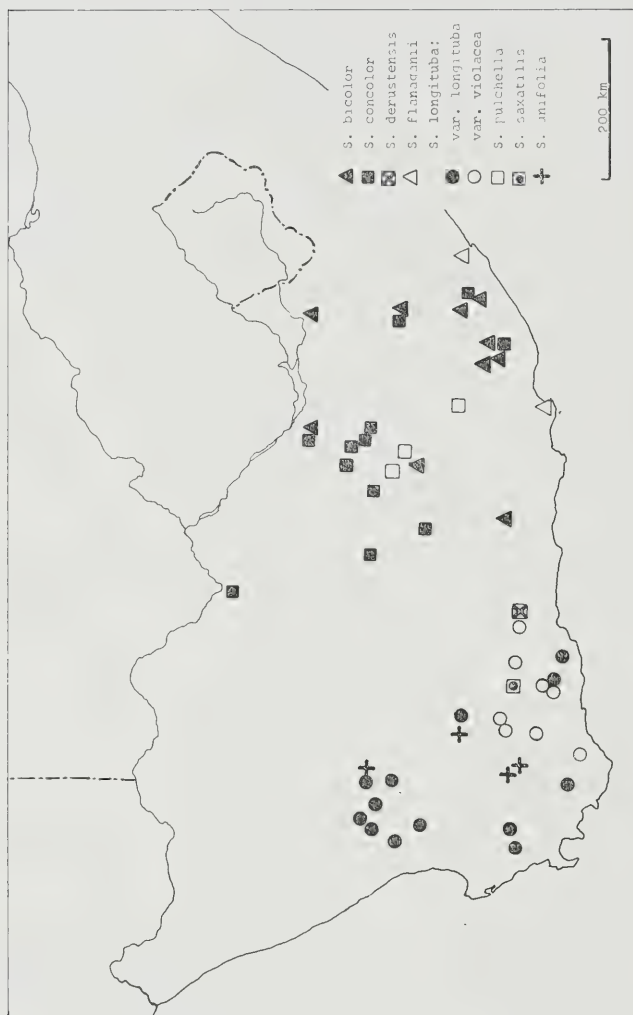


FIG. 10.
Geografiese verspreiding van die *Syringodea*-spesies.

Die afwykende *S. unifolia* is op vier hoë bergplato's van Suidwes-Kaapland gevind.

Volgens die jongste geologiese kaart van die Republiek kom *Syringodea*-spesies op verskillende geologiese lae voor, hoofsaaklik op lae van die Kaapse sisteem en die Karoosisteem. *S. pulchella* is gekry slegs op die Beaufortlae van die Karoosisteem; die verwante *S. concolor* en *S. bicolor* kom meestal op hierdie lae voor. *S. flanaganii* by Komgha is ook op hierdie lae, maar by Port Elizabeth waarskynlik op meer resente lae. *S. longituba* is gevind op Tafelberg-sandsteen en Bokkeveldlae van die Kaapse sisteem, asook op aldie lae van die Karoosisteem, t.w. die Dwyka, Ecce en Beaufort. Die drie spesies met klein areale verskil: *S. derustensis* op Bokkeveldlae, *S. saxatilis* op Witteberglae, en *S. unifolia* op Tafelbergsandsteen, Ecce en Beaufort.

TAKSONOMIESE GESKIEDENIS

Vóór die instelling van die genus *Syringodea* in 1873 is, sover vasgestel kon word, slegs een *Syringodea* spesie beskryf, as *Trichonema longitubum* Klatt (1865–66). Dit is deur Kuntze (1898) na *Syringodea* oorgeplaas.

Tesame met die beskrywing van *S. pulchella* vir plante wat H. Bolus ontdek het in die Sneeuberge van die Groot-Karoo en na Kew gestuur het, het Hooker filius die genus *Syringodea* ingestel (1873) met, onder andere, die volgende kenmerke: baie klein plante wat trompetvormige reëlmatige blomme besit met lang, baie smal blomdekbuis en ses wydspreidende tweelobbigse segmente, regop vry meeldrade in die keel van die blomdek ingeplant, en drie onverdeelde lineêre stempels. Hooker konstateer dat die genus naaste verwant is aan *Trichonema* (nou *Romulea*), wat verskil in sy meestal kort blomdebuis of, indien dit lank is, tregtervormige blomme, meeldrade binne-in die blomdebuis ingeplant, en tweespletige stempels.

Drie jaar later brei Baker (1876a) die omvang van die genus uit om nog twee spesies, *S. filifolia* en *S. bicolor*, in te sluit, met gaafrandige blomdeksegmente en blomme wat volgens hom tregtervormig is. Benthams en Hooker (1883), asook Pax (1888), aanvaar Baker se afbakening van die genus. In die jare voor die verskyning van Baker se uiteensetting van die Iridaceae in die *Flora Capensis* (1896), is 'n verdere vyf spesies beskryf: *S. latifolia*, *S. montana*, *S. minuta* en *S. rosea*, almal deur Klatt (1882), en *S. flanaganii* deur Baker (1893).

In die *Flora Capensis* deel Baker die agt spesies wat toe reeds beskrywe is, in twee subgenera: *Syringodea Proper* met trompetvormige blomme en spreidende, uitgerande blomdeksegmente, met één spesie, *S. pulchella*; en *Crocopsis* met tregtervormige blomme en stygende, gaafrandige segmente, met sewe spesies. Hierdie indeling is ook deur Diels (1930) aanvaar.

Die vier bogenoemde werkers, asook Hutchinson (1959), stem ooreen in die plasing van *Syringodea* tesame met *Romulea*, *Crocus* en *Galaxia*, in 'n eie,

afsonderlike groep: Bentham en Hooker plaas dit in die tribus *Sisyrinchieae* as 'n aparte subtribus *Croceae*; Pax maak dit 'n aparte subfamilie *Crocoideae*; Baker (1896) en Diels volg Bentham en Hooker deur dit in die *Sisyrinchieae* te plaas as aparte groep, wat Baker die tribus *Galaxieae* noem en Diels die subtribus *Crocinae*.

Lewis (1954) egter toon aan dat *Galaxia* morfologies verskil en uit hierdie groep verwyder moet word na die Irideae. Sy is van mening dat *Romulea*, *Syringodea* en *Crocus* in die Ixieae tuishoort, in 'n eie subtribus wat sy die *Romulineae* wou noem (p. 107). In 'n studie van die chromosoommorfologie van die Iridaceae, kom Goldblatt (1971a) tot 'n soortgelyke gevolgtrekking, en hy noem dit die subtribus *Crocineae*. Schulze (1971) se studie van die pollen bevestig ook tot 'n mate Lewis se voorstel; hy stel verder voor dat *Syringodea* en *Crocus* apart van *Romulea* staan, weens die verskille by die pollen.

Ná die verskyning van Baker se uiteensetting in die Flora Capensis (1896) is nog drie spesies beskryf: *S. luteo-nigra* Baker (1897), *S. linifolia* Phillips (1913), en *S. leipoldtii* L. Bolus (1931).

VERWANTSKAPPE

Nie al die soorte wat as *Syringodea*-spesies beskryf is, kan as sulks aanvaar word nie: vier blyk aan verskillende ander genera te behoort, t.w. *S. luteo-nigra*, *S. latifolia*, *S. minuta* en *S. linifolia*. Verder is gevind dat (1) die spesies *S. leipoldtii*, *S. filifolia* en *S. montana* so min van mekaar verskil dat hulle saam gegroepeer behoort te word en een groot polimorfe spesie vorm; en (2) *S. bicolor* var. *concolor* nader aan *S. pulchella* staan as aan *S. bicolor*, maar dat dit tot 'n aparte spesie verhef kan word.

Baker (1896) het sy indeling van die genus in twee subgenera gegrond op die vorm van die oop blom (trompetvormig of tregtervormig) en of die blomdeksegmente ingekeep is of nie. Hierdie indeling kan nie aanvaar word nie want, met 'n hoog genoeg temperatuur soos meestal in hul natuurlike habitats voorkom, open die blomme van al die *Syringodea*s tot 'n nagenoeg trompetvormige fatsoen met horisontaal uitspreidende blomdeksegmente; en die segmente van *S. pulchella* (subgenus *Syringodea* Proper) varieer van tweelobbig tot effens uitgerand en vorm 'n byna kontinue variasiereeks na die gaafrandige *S. concolor* (subgenus *Crocopsis*). Baker se subgenera word dus nie behou nie.

Die noukeurige studie van *S. unifolia* toon dat die kenmerke van die genus *Syringodea* uitgebrei moet word om hierdie spesie in te sluit (sien ook Goldblatt, 1971b). Weens sy enigszins afwykende kenmerke word *S. unifolia* nou in 'n eie subgenus, *Rhipidopsis*, geplaas.

Die huidige ondersoek bevestig dat *Syringodea* naby *Romulea* staan, en wel naaste aan die subgenus *Lomurea* (de Vos, 1972), wat ook trompetvormige pers blomme het met lang smal blomdekbuis. *Syringodea* verskil van *Lomurea*

(asook van subgenus *Romulea*) in sy steeds kort blywende, ondergronds verbergde stingels en pedunculi; in sy koeëlronde nonaperturate stuifmeel, sy onverdeelde of soms veeldelige, maar nie tweespletige, stempels; in die meestal higrochastiese doosvrugte wat slegs in hul boonste gedeelte en met ses kleppe oopspring en wat kort pseudo-pedisels besit bestaande uit die steriele vrugbasisse; en verder veral in sy blaarstruktuur: die volwasse blaar is grotendeels bifasiaal, sonder die vier diagonaal geplaasde lengtgroewe van die romuleas; die stomata is oor byna die hele blaar versprei en nie net in die vier groewe nie; en daar is meestal 'n groot hoeveelheid tannien-bevattende idioblaste in die mesofil aanwesig.

Die groeivorm van *Syringodea* herinner aan dié van *Crocus*, wat ook 'n lang smal blomdebuis, 'n gereduseerde stingel en pedunculus, en ronde, dikwels nonaperturate pollen het. Dit verskil van *Crocus* veral in sy knoltunicae en blaaranatomie, en in sy meestal onverdeelde stempels en die oopsplitting van die vrugte. Die twee genera is nie nader aan mekaar verwant as wat elkeen aan *Romulea* is nie. Die waarskynlikste is dat *Romulea* of sy oervorm in Suid-Afrika oorsprong gegee het aan *Syringodea* en die subgenus *Lomurea*, en in die noordelike half rond aan *Crocus*. 'n Uitsondering met veeldelige stempels is *S. unifolia*; sy knol- en blaarkenmerke toon egter dat dit nader aan *Syringodea* staan as aan *Crocus* en dit word by *Syringodea* ingesluit.

GENUSBESKRYWING

Syringodea Hooker f. Bot. Mag. t. 6072 (1873) nom. cons. (non *Syringodea* D. Don. 1834); Baker 1876a p. 66 et 1877 p. 85 et 1892 p. 95 et 1896 p. 34; Bentham & Hooker 1883 p. 683; Klatt 1882 p. 403 et 1895 p. 160; Pax 1888 p. 475; Kuntze 1898 p. 309; Marloth 1915 p. 136; Arber 1921 p. 327; Diels 1930 p. 463; Phillips 1951 p. 212; Lewis 1954 p. 105; Stopp 1958 p. 38; Hutchinson 1959 p. 651; Goldblatt 1971a p. 393.

Trichonema Klatt 1865–66 p. 665 pro parte.

Tipe-spesie: *S. pulchella* Hook. f.

Klein oorblywende geofiete met gerokte knolle en spruite wat in die ongunstige seisoen verdroog. *Knol* asimmetries, skuins afgeplat na die basis met 'n klein basale rief, of soms vertikaal afgeplat, byna lensvormig en met 'n breë waaivormige vertikale rif; tunicae verskeie, glad, sommige verhout, ander membraneus, bruin, op die basale rif gesplits in kort, fyn, parallelle fibrille en aan die top in skerppuntige tande of onreëlmatig. *Stingel* baie kort, ondergronds verberg deur 'n kraag van ou bruin blaarbasisse. *Laagteblare* meestal 2, membraneus, verberg. *Loofblare* grondstandig, 4 tot ongeveer 9, polistigies, of soms één, grootliks bifasiaal, dikwels filiform, met 'n adaksiale groef, of selde lansetvormig of lineêr, soms effens sukkulent, die onderstes met

breë geslote membraneuse skedes. *Bloeiiwyse* 'n baie verkorte monochasiale rangskikking van 1 tot 5 of soms meer blomme, elkeen terminaal gedra op 'n kort pedunculus en sittend of nagenoeg sittend bo 'n skutblaar en skutblaartjie. *Skutblaar* wit, half-deurskynend, geslote om die vrugbeginsel en basis van die blomdebuis, dikwels met 'n smal groen mediane lengtestreep na die top; *skutblaartjie* soos die skutblaar maar dikwels met 2 smal groen lengtestrepe en uitgerand. *Blomme* verskyn min of meer ná mekaar, trompetvormig wanneer wyd oop, met die basis ondergronds verberg deur blaarbasisse. *Perigoniumbuis* baie lank, smal, reguit, buisvormig, meestal ca. 1 mm in deursnee, aan die top effens verbreed; *segmente* korter as die buis, die twee kranse byna eenders, ellipties of smal omgekeerd-eiervormig, stomp tot skerp of soms diep gekeep, violet, violet-blou of soms blou of wit, dikwels geel of wit in die keel, die buitenste segmente soms met 'n ligte kol agter. *Meeldrade* in die keel van die blom ingeplant, vry, meestal uitgestoot, simmetries rondom die styl; *helmdrade* dun, regop, gegroef aan die binnekant, meestal naak en wit; *helmknoppe* lineêr, met 'n pylpuntvormige basis, regop of soms effens spreidend of ingebuig; *pollen* koeëlvormig, nie-aperturaat, spinulaat, goudgeel. *Vrugbeginsel* klein, met talryke saadknoppe in elke hok; *styl* filiform, regop, langer as die blomdebuis, met drie kort takke wat die stempels is; *stempels* meestal verleng, gekondupliseer of gegroef, met papille op die rande, spatelvormig aan die toppe of selde veel-delig of uitgerafel. *Doosvrugte* meestal knuppelvormig of tolvormig, higrochasties, oopsplitsend met ses kleppe aan die top, of selde xerochasties met drie kleppe; *sade* talryk, klein, rond of hoekig gedruk, bruin tot swart, met retikulate tot foveate of kollikulate ornamentasie. *Chromosoomgetal* $2n = 12$, selde 22.

SLEUTEL TOT DIE SUBGENERA EN SPESIES

- 1 Knol nagenoeg omgekeerd-eiervormig of soms onreëlmatig, met 'n klein riffie aan die basis wat kleiner is as die breedte van die knol; loofblare verskeie of soms een; stempels onverdeeld of soms uitgerafel Subgenus *Syringodea*
- 2 Loofblaar een uit 'n knol spruitend, effens opgeswel, soms skynbaar 2 of meer maar dan uit meer as een opmekaar gedronge knolle 7. *S. saxatilis*
- 2 Loofblare verskeie uit 'n knol spruitend.
 - 3 Blomdeksegmente (perigoniumsegmente) ingekeep of tweelobbig 1. *S. pulchella*
 - 3 Blomdeksegmente gaafrandig, stomp tot skerp.
 - 4 Soom van die blomdek meestal minder as 16 mm in deursnee, die segmente 5–8 mm lank, ca. 2 mm breed 4. *S. flanaganii*
 - 4 Soom van die blomdek 20 mm of meer in deursnee, selde slegs 16 mm, die segmente 10 mm of langer, en breër as 4 mm.
 - 5 Loofblare 3–6 mm breed 6. *S. derustensis*
 - 5 Loofblare 0,3–1,5 mm of selde tot 2,5 mm breed.
 - 6 Blomme 6–10 cm lank, korter as die blare; knol 10–18 mm in deursnee, selde kleiner, byna skerp-puntig aan die basis, met 'n klein basale riffie baie kleiner as die deursnee van die knol; blare met 8 of meer vaatbundels (dwarssnee).
 - 7 Blomdek geel tot oranje-geel in die keel 3. *S. bicolor*
 - 7 Blomdek nie geel in die keel nie 2. *S. concolor*

- 6 Blomme 3–6 cm lank, selde korter, steek dikwels bo (hoër as) die blare bo die grond uit; knol 5–10 mm in deursnee, soms in groepe tesame wat tot 20 mm breed is; elke knol met 'n basale riffie wat net effens smaller is as die knol self; blare met 5 of soms tot 9 vaatbundels (dwarssnee)
S. longituba

1 Knol vertikaal afgeplat, byna lensvormig, met 'n breë, vertikale, waaivormige rif wat drie-kwart om die knol loop; meestal een loofblaar; stempels veeldelig
 Subgenus *Rhipidopsis* en 8. *S. unifolia*

A. Subgenus SYRINGODEA

Knol asimmetries, nagenoeg omgekeerd eivormig, effens skuins afgeplat na die basis, met 'n klein basale rif wat smaller is as die knol. *Blare* meestal meer as een (een by *S. saxatilis*), sonder subepidermale kollenchiemstroke (dwarssnee). *Blomme* met drie onverdeelde, of selde uitgerafelde, stempels. *Vrugte* higrochasties, oopsplitsend met ses kleppe in die tophelfte of -kwart. *Chromosoomgetal* $2n = 12$.

Die harde knoltunicae het 'n kristalryke subepidermale sklerenchiemlaag aan die buitekant (abaksiaal) met die selle of palissade-agtig of parallel met die lengteas van die tunicae geplaas. Platysklereïede (sien onder Anatomie) kom nie hier voor nie. Die blare verskil heelwat in vorm by die verskillende spesies en is filiform tot lineêr of lansetvormig, 0,5–6 mm breed; hulle besit vyf tot talryke vaatbundels, en is sonder kollenchiemstroke. Die saadhuide is retikulaat-foveaat, foveaat of soms kollikulaat, is dunner as by subgenus *Rhipidopsis* en bestaan uit slegs twee nábywende sellae. Die subgenus word in twee seksies ingedeel.

Seksie SYRINGODEA

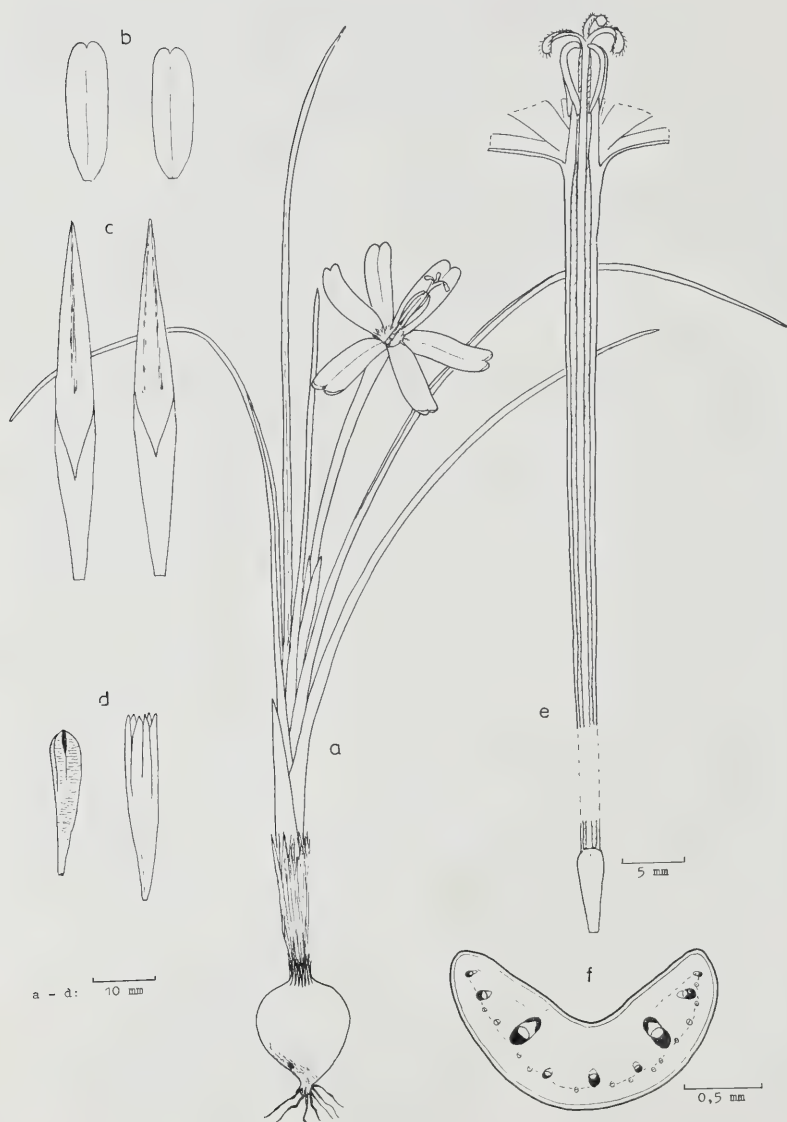
Knol byna skerp aan die basis met 'n baie klein basale riffie; knoltunicae glad buite en met 'n subepidermale sklerenchiemlaag van langer of korter palissade-agtig gerangskikte steenselle met baie stippels en met isodiametriese kristalbevattende idioblaste op verskillende dieptes (Fig. 3a). *Blare* langer as die blomme, tot 1,5 of soms tot 2 mm breed. *Testa*-ornamentasie retikulaat-foveaat.

Vier naverwante spesies hoort aan die seksie, van die Groot-Karoo en Oostelike Kaapprovinsie. Daar is genoegsame rede om een, wat deur Baker (1892) beskryf is as 'n variëteit van *S. bicolor*, tot spesie te verhef. 'n Ander, *S. flanaganii*, mag miskien 'n kleiner variasie van *S. bicolor* wees, maar omdat dit nie vars ondersoek kon word nie, word dit hier as spesie behou.

1. *Syringodea pulchella* Hooker f. in Bot. Mag. t. 6072 (1873); Baker 1876a p. 67 et 1877 p. 85 et 1892 p. 95 et 1896 p. 34; Klatt 1882 p. 403 et 1895 p. 160; Benthams & Hooker 1883 p. 693; D(arnell) 1927 p. 79.

Icones: Bot. Mag. t. 6072 (1873); Flore des Serres II (10) t. 2096 (1874); Garden 9: 353 (1876); Gard. Chron. 81: 79 fig. 41 (1927); hierdie werk Fig. 11.

Holotipe: *Bolus* 1852 in K; isotype in BOL.



Plant 12–20 cm hoog. *Knol* effens asimmetries, byna tolvormig of omgekeerd-eiervormig, 8–15 mm in deursnee, met 'n taamlike skerp basis gevorm deur 'n klein riffie; tunicae glad, bruin, dikwels met fyn parallelle fibrille op die basale riffie, aan die top met skerp tande ca. 5 mm lank. *Stingel* 5–8 mm lank, verberg onder 'n kraag van ou bruin blaarbasisse tot 30 mm hoog. *Blare* 3–6, filiform met 'n liggroen adaksiale lengtegroefie tot naby die top, 10–25 cm lank, minder as 1 mm tot 1,5 of soms tot 2 mm breed, naak of fyn gesilieerd op die rande, meestal gebuig en spreidend, met wye membraneuse blaarskedes. *Pedunculi* 5–8 mm lank, verberg. *Skutblaar* 40–45 mm lank, membraneus, groenerig in die boonste helfte of met 'n smal groen mediane strook en wye kleurlose, dof-gespikkelde rande, reikend tot die helfte of byna die helfte van die blomdebuis. *Skutblaartjie* met twee smal groen lengtestroke in die boonste helfte. *Blomme* 1–4 of soms 5, effens geurig, 70–120 mm lank. *Blomdek* trompetvormig, met die soom 25–50 mm in deursnee; *blomdebuis* 60–100 mm lank, smal, ca. 1,5 mm in deursnee, geleidelik wyer tot 2,5 mm aan die top; *segmente* smal omgekeerd-eiervormig of wigvormig-spatelvormig, diep gekeep of tweelobbig, met die punte rond en effens opgebui, 12–22 mm lank, 5–7 mm breed, lilakleurig (RHS 75D, 76B, C, D), soms met 'n klein diffuse bloueriige kol aan die basis van elke segment; buitenste segmente met fyn pers are of 'n pers mediane strook aan die buitekant, effens groter as die binneste segmente. *Meeldrade* uitgestoot, orent; *helmdrade* 3–4 mm lank, dig teenmekaar, wit; *helmknoppe* 5–9 mm lank, effens ingebuig aan die punte. *Vrugbeginsel* ca. 4 mm lank; *styl* 65–120 mm lank, wit; *stempels* ca. 4 mm lank, spatelvormig aan die toppe, wit, reikend vanaf die middel van die helmknoppe tot bo hul toppe. *Doosvrugte* 20–30 mm lank, knuppelvormig met 'n smal pseudo-pedisellate basis, met fyn dwars rimpels, oopsplitsend met ses regop kleppe aan die top; *sade* hoekig of byna rond, 1,5 mm in deursnee, swart, met retikulaat-foveate ornamentasie. *Chromosoomgetal* $2n = 12$.

KAAP—3124 (Hanover). In campos inter montes Sneeuberg (CB): *Bolus* 1852 (K, BOL). Langs pad tussen Graaff-Reinet en Middelburg (DC): *de Vos* 2257B (STE).

3225 (Somerset-Oos). Plato bo-op Bosberg naby Somerset-Oos (DA): *MacOwan* 827 (SAM).

Blomtyd Maart tot April.

Die spesie het skynbaar 'n klein verspreiding in die middel van die Groot-Karoo. Dit word gekenmerk deur verskeie lang, dun, draadvormige blare met,

FIG. 11.

Syringodea pulchella (*de Vos* 2257B). a, plant; b, buitenste en binneste blomdeksegmente; c, skutblaar (links) en skutblaartjie (regs); d, vrug, geslote en oopgesplits; e, blomdebuis, androeceum en gynoecium; f, dwarsnee van 'n blaar.

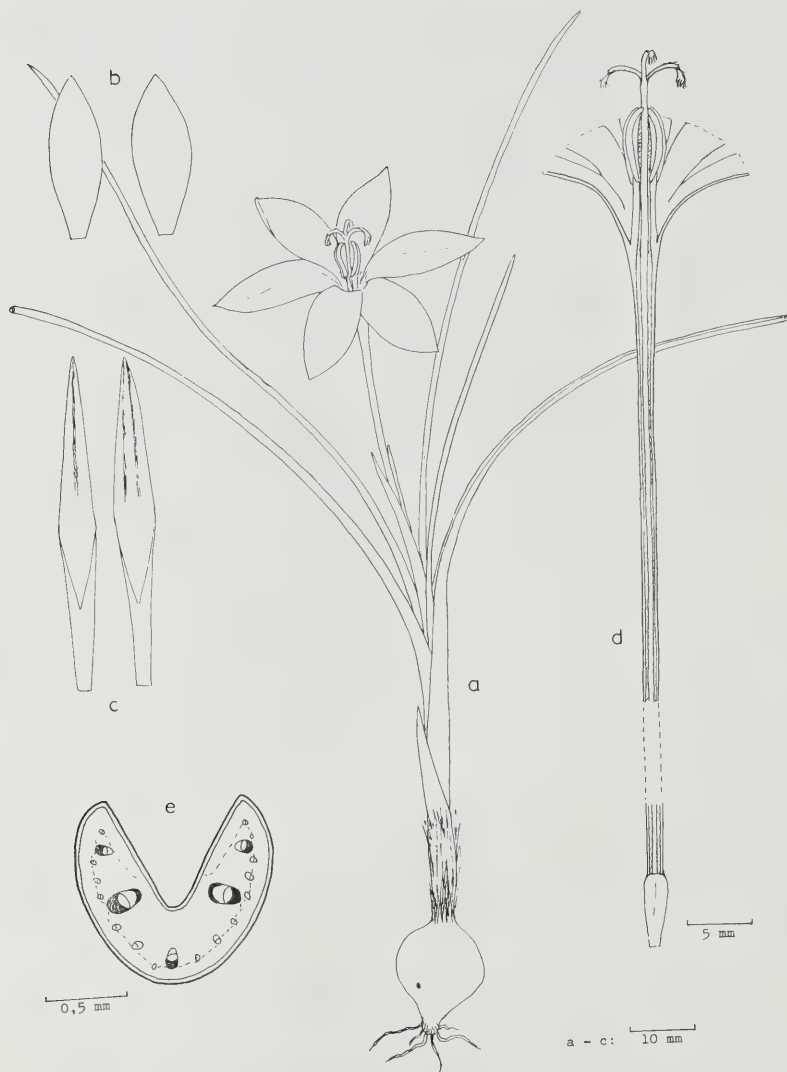


FIG. 12.

Syringodea concolor (Malan STE 30369). a, plant; b, buitenste en binneste blomdeksegmente; c, skutblaar en skutblaartjie; d, blomdekbuis, androecium en gynoecium; e, dwarssnede van 'n blaar.

in die vars toestand, 'n liggroen groefie aan die bokant, lig lilakleurige blomme met 'n baie lang blomdebuis en met segmente wat diep of vlak gekeep is aan hul toppe. Die blomme open reeds taamlik vroeg in die oggend en het nie 'n besonder hoë temperatuur daarvoor nodig nie; die blomdeksegmente raak gou horisontaal gesprei met punte wat na bo gebuig is.

Wanneer die droë vrug natgemaak word, strek dit tot byna 20 persent langer en verloor sy dwars rimpels. Na 'n paar maal se natwording splits dit aan die top oop binne 'n paar sekondes, met ses regopstaande kleppe. Met uitdroging buig die kleppe terug en sluit die vrug gedeeltelik.

2. *Syringodea concolor* (Baker) de Vos stat. nov.

S. bicolor Baker var. *concolor* Baker 1892 p. 96 et 1896 p. 35.

Fig. 12.

Holotype: *Tyson 346* in K.; isotipes in BOL, SAM.

Plante 10–25 cm hoog. *Knol* effens asimmetries, byna tolvormig of omgekeerd-eiervormig, 10–18 mm in deursnee of soms effens kleiner, met 'n skerperige basis gevorm deur 'n baie klein riffie; tunicae glad, bruin, met fyn parallelle fibrille op die basale riffie, aan die top onreëlmatig of in skerp tande ca. 5 mm lank gesplits. *Stingel* kort, verberg onder 'n kraag van ou bruin blaarbasisse wat tot 40 mm hoog is. *Blare* 4 of meer, filiform met 'n liggroen adaksiale lengtegroefie, dikwels gekondupliseerd in die droë toestand, 10–25 cm lank, 0,5–1,5 mm breed, fyn gesilieerd op die rande of soms naak, gebuig en spreidend of soms byna regop, die buitenste blare met breë membraneuse blaarskedes. *Pedunculi* kort, verberg. *Skutblaar* 25–35 mm lank, membraneus, in die boonste helfte groenerig of met 'n smal groen mediane strook en membraneuse, soms bruingespikkelde rande, reikend tot die helfte of onder die helfte van die blomdebuis. *Skutblaartjie* 2-kielig, met twee smal groen lengtestroke in die boonste deel. *Blomme* 1–4, 60–100 mm lank, selde langer of korter. *Blomdek* trompetvormig, met die soom 25–50 mm in deursnee; *blomdebuis* 50–80 mm lank of soms net 40 mm, ca. 1 mm in deursnee, aan die top verbreed tot 3 mm; *segmente* smal omgekeerd-eiervormig of smal ellipties, byna skerp tot stomp, effens konkaf, 12–20 mm lank, 5–9 mm breed, ligviolet of lig persblou (RHS 76A–C, 84D), soms byna wit, soms donkerder pers aan die basisse, wit in die keel. *Meeldrade* uitgestoot, regop; *helmdrade* 5–8 mm lank, dig teenmekaar, wit; *helmknoppe* 5–8 mm lank, ingebuig aan die punte. *Vrugbeginsel* 3–4 mm lank; *styl* 50–85 mm lank, wit; *stempels* 4–5 mm lank, effens verbreed aan die punte of soms uitgerafel, reikend tot bo die helmknoppe of laer. *Doosvrugte* 12–20 mm lank, knuppelvormig met 'n smal pseudo-pedisellate basis, met fyn dwars rimpels, oopsplitsend aan die top met ses kleppe; *sade* effens hoekig, ca. 1,5 mm in deursnee, swart, met 'n fyn retikulaat-foveate ornamentasie. *Chromosoomgetal* $2n = 12$.

- KAAP—2922 (Prieska). Nelspoortjie (CD): *Bryant J301* (BOL, PRE, K).
 3025 (COLESBERG). Joubert, Witteberge (CA): *Thode A518* (PRE).
 3123 (VICTORIA-WES). 10 ml. Oos van Victoria-Wes (AC): *Comins 823* (PRE). Naby Richmond (BD): *Malan STE 30369*. Coetzierskraal, Murraysburg: *Tyson 346* (BOL, SAM, K).
 3124 (HANOVER). 20½ ml. NW. van Noupoot (BA): *Acocks 14298* (PRE). Naby Noupoot (BB): *Denoon 26* (BOL), *Cross 15* (NBG). Dwaal, Plaatjiesfontein (BA): *Hatchard BLF 8993*. Plato N. van Sneeuweg (CB-DA): *Shaw 1972* (BOL).
 3125 (STEYNSBURG). Maryland, Schoombie-Vlakte (AD/BC): *Thorns Apr. 1944* (NBG). Grootfontein (AC): *Theron 280, 460, Acocks 17973* (PRE). Bangor (AC) *Bolus 14134*.
 3126 (QUEENSTOWN). Summit Madeira-heuwel (DD): *Galpin 7812* (GRA, PRE).
 3227 (STUTTERHEIM). King William's Town (CD): *Latimer SAM 54910*.
 3326 (GRAHAMSTOWN). Kransdrif-weg (BC): *Britten 5724* (GRA).
 Blomtyd: Maart–April.

S. concolor kan maklik uitgeken word aan sy meestal groot knol met 'n taamlik puntige basis, baie klein basale riffie en gladde blink tunicae, groot ligviolet of ligblou tot byna wit blomme met 'n besonder lang buis, sonder 'n geel blomdekkeel en sonder ingekeepte segmente, en aan sy smal blare wat langer is as die blomme en wat in die vars toestand 'n liggroen adaksiale lengte groefie vertoon. Variasie kom voor in die breedte van die blomdeksegmente en die skerpte van hul punte.

Die drie spesies, *S. concolor*, *S. pulchella* en *S. bicolor* staan naby mekaar, met dieselfde knolvorm, tunica-anatomie, blaaranatomie, groot blomme en doosvrugte. Baker (1892, 1896) het *S. concolor* as 'n variëteit van *S. bicolor* beskou. Dit verskil van die laasgenoemde in die kleur van die blomdekkeel, die helmrade en styl, asook in die saad: die testa is swart en fyn retikulaat-foveaat, waar dié van *S. bicolor* bruin is met 'n groter retikulasie. Omrede hierdie verskille word dit nou tot spesie verhef. *S. concolor* staan moontlik nader aan *S. pulchella* en verskil hoofsaaklik in die vorm van die blomdeksegmente (nie ingekeep, dikwels breër) en in die effens smaller blomdekbuis wat slegs naby die top skielik breër word. Hul saadhuid is eenders.

Enkele ou kolleksies mag miskien verkeerd geplaas wees weens die moontlikheid dat 'n oorspronklike geel keel kon verbleik het; bv. *Galpin 7812* van Queenstown en *Britten 5724* van Grahamstown (beide nou by *S. concolor* aangegee); ook *Sim 2209* van Doutsah, Kaffraria. Hoewel *Drège 3498* in B, BM, K, en P, se blomdekkeel nie meer geel vertoon nie, word dit as *S. bicolor* beskou, daar die *Drège* eksemplare in S sonder twyfel hierdie spesie is. *Cross 15*

in NBG se blomme is klein vir *S. concolor*, maar die knolle, asook die anatomie van die knoltunicae, is tipies vir die spesie.

3. *Syringodea bicolor* Baker in J. Bot. 5: 67 (1876a) syn. excl. et 1877 p. 86 syn. excl. et 1892 p. 96 et 1896 p. 35 syn. et var. excl.; Klatt 1882 p. 403 et 1895 p. 160 pro syn.; Kuntze 1898 p. 309 pro syn.; Martin & Noel 1960 p. 29.

Fig. 13.

Lektotipe: Burke 446 in K.

Plante 6–20 cm hoog. Knol effens asimmetries, byna tolvormig of omgekeerd-eiervormig, 10–15 mm in deursnee, of soms net 7 mm, met 'n skerperige basis gevorm deur 'n baie klein riffie; tunicae glad, bruin, met fyn parallelle fibrille op die basale riffie, aan die top onreëlmatig gesplits of in skerp tande ca. 5 mm lank. *Stingel* kort, verberg onder 'n kraag van ou bruin blaarbasisse 10–30 mm hoog. *Blare* 4 of meer, filiform, met 'n liggroen adaksiale lengtegroefie, dikwels gekondupliseerd in die droë toestand, 6–20 cm lank, 0,5–1 mm of soms tot 1,5 mm breed, fyn-gesilieerd op die rande of soms naak, meestal gebuig en spreidend, die buitenste blare met breë membraneuse skedes. *Pedunculi* baie kort, verberg. *Skutblaar* 20–45 mm lank, membraneus, groenerig in die boonste helfte of met 'n groen mediane strook en breë membraneuse, soms bruin gespikkelde rande, reikend tot bo of tot onder die helfte van die blomdekbuis. *Skutblaartjie* soms effens langer, tweekielig, met twee smal groen lengtestroke in die boonste deel. *Blomme* 1–4, 65–100 mm lank of soms net 50 mm. *Blomdek* trompetvormig wanneer wyd oop, met die soom 40–55 of soms net 25 mm in deursnee; *blomdebuis* 45–70 mm lank, of soms net 30 mm, 1 mm breed, aan die top tot 3 mm breed; *segmente* omgekeerd-eiervormig tot smal omgekeerd-eiervormig, stomp tot halfstomp, dikwels effens konkaf, 18–28 mm lank of soms net 12 mm, 7–10 mm breed of soms net 5 mm, lig tot helder violet (RHS 85A, B) of soms wit, oranje-geel aan die basisse en in die keel, die buitenste segmente effens groter as die binneste. *Meeldrade* uitgestoot, regop; *helmdrade* 5–8 mm lank, dig teenmekaar, geel; *helmknoppe* 5–8 mm lank, dikwels effens spreidend en die punte ingebuig, soms met die basisse vas aanmekaar. *Vrugbeginsel* ca. 5–6 mm lank; *styl* 50–75 mm lank, liggeel; *stempels* 4–5 mm lank, lineêr, min verbreed aan die punte, reikend die helmknoppe of hoër of laer. *Doosvrugte* 15–20 mm lank, knuppelvormig met 'n smal pseudo-pedisellate basis, met fyn dwarsrimpels, oopsplitsend aan die top met ses regop kleppe; *sade* meestal hoekig, ca. 1,5 mm in deursnee, bruin, met retikulaat-foveate ornamentasie met ca. 5–6 interstitia per mm. *Chromosoomgetal* $2n = 12$.

BECHUANALAND. Vetrivier: Zeyher 446 (SAM).

KAAP—3025 (COLESBERG). Colesberg (CA): Shaw s.n. (K).

3027 (LADY GREY). Witberge, rotsige plekke en tussen gras (CA): Drège 3498 (S e.a. herbaria).

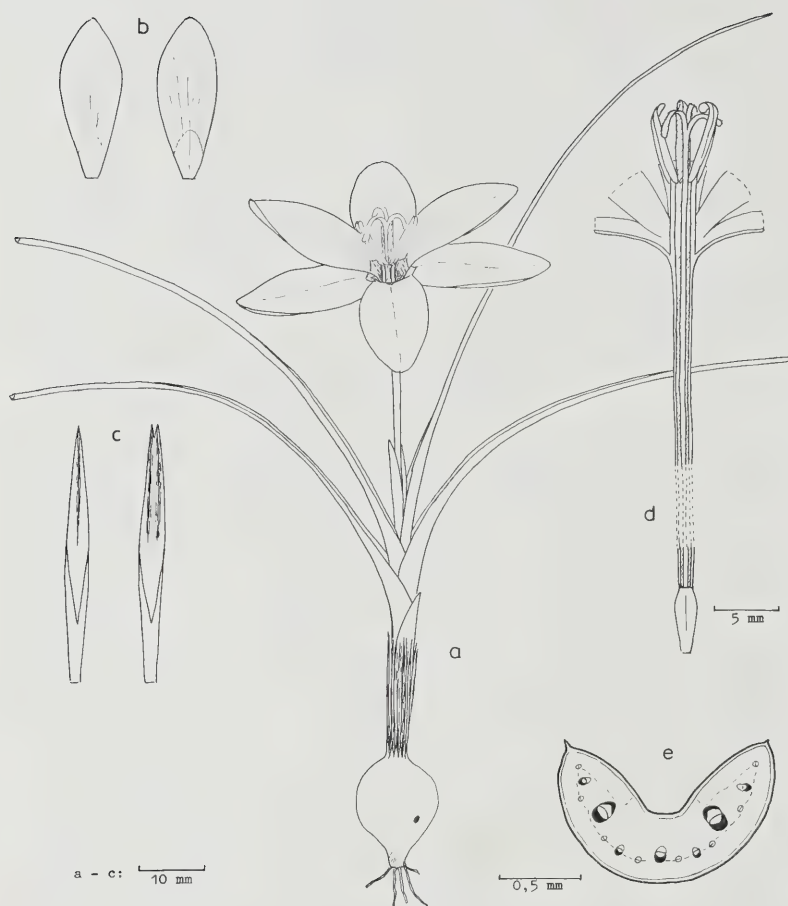


FIG. 13.

Syringodea bicolor (Barker 10642b). a, plant; b, buitenste en binneste blomdeksegmente; c, skutblaar en skutblaartjie; d, blomdekbuis, androecium en gynoecium; e, dwarssnede deur die blaar.

- 3224 (GRAAFF-REINET). Graaff-Reinet (BA): *Bowker* 9 (K).
 3225 (SOMERSET-OOS). *Bowker* s.n. (K). Vlei naby Somerset-Oos (DA): *Bayliss* 1304 (NBG, PRE).
 3227 (STUTTERHEIM). Keiskammahoek (CA): *Gonlomis* BOL 22945. Pirievlakte bo Ross-Sendingstasie (CC): *Leighton* s.n. (GRA).
 3323 (WILLOWMORE). Trompetterspoort (BA): *Ecklon & Zeyher* SAM 21576.
 3326 (GRAHAMSTOWN). Grahamstown (BC): *MacOwan* s.n. (K). Naby Grahamstown: *Bolton* s.n. (K), *MacOwan* 827 (SAM). Carlislebrug (AB): *Bayliss* 2183 (NBG, B). 7 ml. langs Cradockpad (AB): *Dyer* 1312 (GRA). Cradockpad: *Cheadle* 751 (PRE). Alicedale (AC): *Cruden* 256 (GRA, STE). Pad na Alicedale: *Wells & Britten* s.n. (GRA). Langs pad na Riebeeck-Oos (AA-BC): *Saunders* s.n. (GRA). Hermanuskraal aan die Groot-Visrivier: *Ecklon & Zeyher* s.n. (S).
 ? . . . Fat River: *Burke* 446 (K).

Blomtyd Maart tot April, soms Januarie.

S. bicolor word maklik uitgeken aan sy meestal groot knol met 'n taamlik puntige basis en gladde blink tunicae, besonder groot, violet blomme met 'n geel gekleurde keel, en blare wat langer is as die blomme en wat in die vars toestand 'n liggroen mediane lengtegroefie in die adaksiale kant toon. Variasie kom voor veral in die breedte van die blomdeksegmente.

Die vrug is soos by *S. pulchella* en *S. concolor* en splits ook net so oop. Die sade egter is bruin met 'n growwer maasnetwerk daarop.

S. bicolor is deur Baker (1876a en verder) en ná hom deur Klatt (1895) en Kuntze (1898) as dieselfde as *S. longituba* beskou. Maar die huidige studie van die tipes toon dat hierdie spesies nie dieselfde is nie—o.a. is ook die knoltunicae anatomies verskillend. Sien verder onder *S. longituba*.

Baker se tweede variëteit van die spesie, var. *concolor*, word nou as 'n aparte spesie beskryf.

Drège 3498 in S bestaan uit groot, tipiese plante van *S. bicolor* en kleiner plante. In die meeste ander herbaria wat *Drège* 3498 besit, is die plante kleinerig en so verbleik dat 'n geel blomdekkeel nie uitgeken kan word nie. Hulle word egter ook as *S. bicolor* aanvaar. *Kolbe & Pegler* 1615 van Cala (BOL) is heelwat kleiner en mag hierdie spesie wees.

4. *S. flanaganii* Baker in Kew Bull. 1893: 158 et 1896 p. 35.

Plante 3–12 cm hoog. *Knol* effens asimmetries, omgekeerd-eiervormig, 4–10 mm in deursnee, met 'n skerp basis gevorm deur 'n uiters klein riffie; tunicae glad, bruin, dikwels blink, met 'n paar fyn fibrille op die basale rif, aan die top onreëlmatig gesplits. *Stingel* baie kort, verberg onder 'n kraag van ou bruin blaarbasisse 15–30 mm hoog. *Blare* 6–9, filiform, gekondupliseerd of met 'n smal adaksiale groefie, 30–100 mm lank, 0,5 mm of minder of soms tot 1 mm

breed, byna regop of gebuig, met fyn-gesilieerde rande. *Pedunculus* kort, verberg. *Skutblaar* ca. 12–25 mm lank, membraneus met kort bruin strepies en 'n smal, groen, mediane strokie in die top helfte, reikend tot die middel van die blomdekbuiss. *Skutblaartjie* met 2 smal groen lengtestrokies na die top. *Blomme* een of soms tot 3, 30–50 mm lank of soms kleiner. *Blomdek* met die soom tot ca. 16 mm in deursnee; *blomdekbuiss* ca. 25–45 mm lank, minder as 1 mm in droë toestand, ca. 1,5 mm aan die top, geel (sic Baker) of perserig; *segmente* 5–8 mm lank, ca. 2 mm breed, donkerpers, geel in die keel, die buitenste omgekeerd-lansetvormig, die binneste omgekeerd-lansetvormig-langwerpig (sic Baker), stomp. *Meeldrade* uitgestoot; *helmdrade* ca. 1,5–2 mm lank; *helmknoppe* ca. 3 mm lank. *Styl* ongeveer so lank soos die blomdekbuiss of effens langer; *stempels* ca. 1 mm lank, breed-spatelvormig, reikend onder die helmknop-toppe. *Doosvrug* ca. 7–8 mm lank, bruin gespikkeld, sonder dwarsrimpels; *sade* ca. 1,5 mm in deursnee, byna swart met 'n groterige retikulaat-foveate ornamentasie. *Holotype*: *Flanagan* 720 in K; isotipes in BOL, PRE, SAM, B.

KAAP—3227 (STUTTERHEIM). Top van Gonubie-heuwel naby Draaibos en Komgha (DB): *Flanagan* 720.

3325 (PORT ELIZABETH). Korsten (DC): *Long* 989 (BOL, GRA, PRE, K), *Reed* s.n. (GRA). Bakensrivier (DC); *Long* Junie 1931 (BOL).

Blomtyd April tot Junie.

Hierdie spesie wat slegs uit herbariummateriaal bekend is, is net in die Oostelike Kaapprovinsie gevind. Miskien is dit slegs 'n kleiner variant van *S. bicolor*. Aangesien dit tog onderskeibaar is van die ander spesies, word dit hier apart behou. Dit word gekenmerk deur 'n blom met besonder klein blomdeksegmente (die kleinste in die genus), met 'n geel keel, kort breë stempels, en 'n knol en tunicae soos by *S. bicolor*, hoewel kleiner. Baker het die blare as naak beskryf, maar met 'n lens is 'n ry uiters klein wit haartjies op die blaarrande sigbaar.

Bayliss 2760 van Wodehouse, Dordrecht, 6 000' in NBG en *Paterson* 2452 van Redhouse naby Port Elizabeth in BOL en GRA, bestaan uit effens groter plante met effens groter blomme en langer meeldrade, en lyk intermediêr tussen *S. flanaganii* en *S. bicolor* of *S. longituba*.

Seksie SAXATILES De Vos sect. nov.

Cormus fere obovoideus crista obliqua basilari parum angustiore quam cormo; tunicae extus interdum asperae. *Folia* plura vel interdum 1, angusta vel lata. *Testa* colliculata vel foveolata.

Typus sectionis *S. saxatilis* De Vos.

Knol nagenoeg omgekeerd-eiervormig met 'n smal skuins basale riffie wat effens smaller is as die knol en breër as by die tipiese seksie; tunicae glad of

skurf buite, met 'n subepidermale laag veselagtige sklerenchiem, die selle waarvan min of meer parallel met die lengte-as van die tunica lê, en met kristalbevattende idioblaste in 'n laag vlak onder die epidermis; die kristalle is isodiametries of verleng; op plekke waar hulle afwesig is, word die sklerenchiem soms opgehewe en veroorsaak dit die skurwe buite-oppervlakte (Fig. 3b-d). *Blare* verskeie of soms een, smal en filiform (ca. 0,5 mm breed) of plat en liniêr of soms lansetvormig (tot 6 mm breed). *Testa* met 'n kollikulate of foveolate ornamentasie.

Drie spesies, hoofsaaklik uit die westelike karoïede distrikte, die Klein-Karoo en die suidkusdistrikte. *S. longituba* is 'n polimorfe spesie met 'n wye verspreiding en is voorheen as vier aparte spesies beskou. Daar is nou soveel tussenstadia en variasiekombinasies bekend, dat die vier spesies nie in stand gehou kon word nie. Die ander twee is nuutontdekte spesies, elk op net één plek gevind.

5. ***S. longituba*** (Klatt) Kuntze, Rev. Gen. Pl. 3 (2): 309 (1898) pro parte, excl. syn. *S. bicolor* Bak.

Holotipe: *Mund & Maire 1101* in B.

Plante meestal 4–10 cm hoog. *Knol* nagenoeg omgekeerd eivormig, effens skuins afgeplat na die basis, 5–20 mm in deursnee, met 'n platterige basale riffe 4–6 mm breed; tunicae bruin, glad of soms met 'n skurwe oppervlakte, met fyn parallelle fibrille op die basale rif, aan die top onreëlmatig gesplits. *Stingel* 5–40 mm lank, verberg onder 'n kraag van ou bruin blaarbasisse 15–50 mm lank. *Blare* gewoonlik 6–8, selde meer of minder, filiform en byna tereet of soms taamlik plat of met 'n smal adaksiale groefie, 15–60 mm lank, meestal minder as 1 mm tot 1,5 mm breed, selde tot 2 mm, gebuig, golwend, opgekrul, of soms byna regop of geroteer met 'n regsom torsie, fyn gesilieerd op die rande of naak. *Pedunculi* baie kort of tot 18 mm lank, verberg. *Skutblaar* 15–25 mm lank, membraneus met 'n smal groen mediane strook in die top-helfte en meestal fyn bruin strepies, reikend tot ongeveer die helfte van die blomdebuis. *Skutblaartjie* met twee smal groen lengtestroke in die top helfte. *Blomme* 1–4 of soms meer, 30–50 mm lank of soms effens kleiner. *Blomdek* trompetvormig, die soom 20–25 mm, soms slegs 16 mm of tot 30 mm in deursnee; *blomdebuis* 20–33 mm lank of soms net 15 mm, ca. 1 mm in deursnee, aan die top tot 3 mm verbreed; *segmente* omgekeerd-eivormig, effens konkaf, stomp tot halfskerp, 10–15 mm lank, 4–8 mm breed, soms slegs 8 × 3 mm, helder blou-violet (RHS 76A, 88C, 91B, 92A, B), die keel geel, oranje-geel, wit of violet; die buitenste segmente effens groter as die binnesten en soms met 'n ligte mediane kol aan die buitekant. *Meeldrade* uitgestoot of soms met slegs die helmknoppe uitgestoot; *helfmeeldrade* 3–5 mm of soms tot 8 mm lank, regop, wit, soms geel of pers; *helfmeeldrade* 3–6 mm lank, oranje-geel, regop of effens

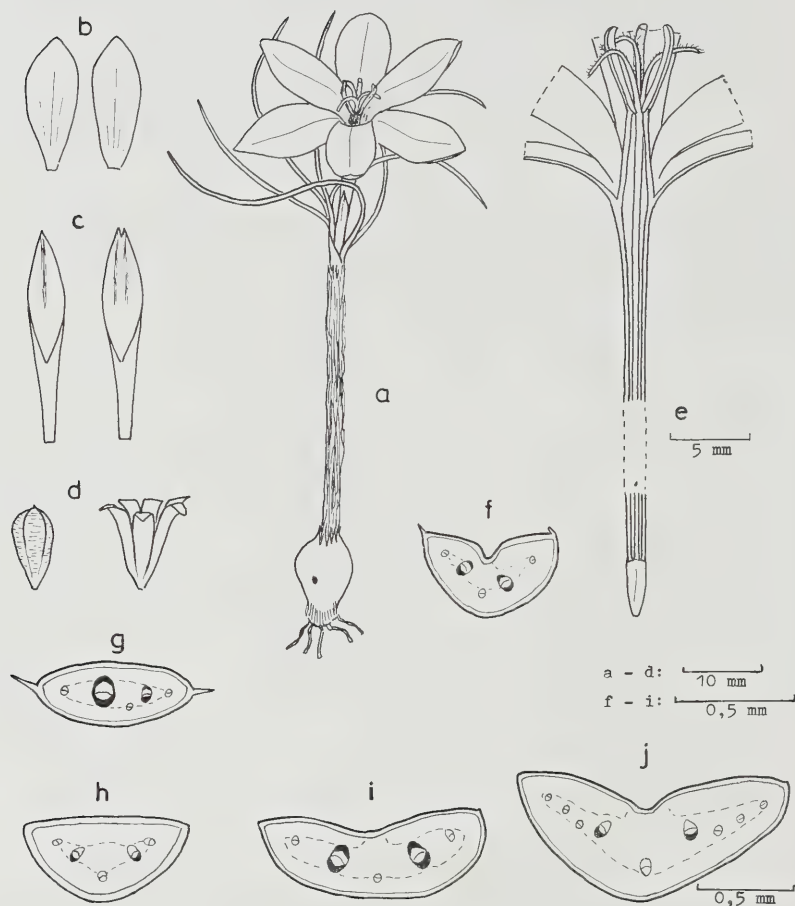


FIG. 14.

Syringodea longituba var. *violacea* (de Vos 2270): a, plant; b, buitenste en binneste blomdeksegmente; c, skutblaar en skutblaartjie; d, vrug, geslote en oopgesplits; e, blomdebuis, androecium en gynoecium; f, dwarsnee deur die blaar; g-j, dwarsnee deur blare om variasie te toon; g, var. *violacea* (de Vos 2266), h-j, var. *longituba* (Oliver 3391, de Vos 2271, 2268 onderskeidelik).

ingekrom. *Vrugbeginself* 2–3 mm lank; *styl* 25–40 mm lank of soms net 20 mm; *stempels* 2–4 of soms tot 5 mm lank, die toppe soms verbreed, geel of wit, reikend tot bo die helmknoppe of laer. *Doosvrugte* tolvormig of lank-tolvormig, 8–25 mm lank, met fyn dwars rimpels, dikwels met 'n kort pseudo-pedisellate basis, oopsplitsend met 6 teruggebuigde kleppe in die top-kwart tot helfte; *sade* taamlik hoekig, ca. 1 mm in deursnee, donkerbruin, fyn foveaat, soms deels kollikulaat. *Chromosoomgetal* $2n = 12$.

Blomperiode April tot Junie.

S. longituba word gekenmerk deur 'n knol met 'n groter basale rif as by *S. pulchella*, ens., en net effens smaller as die knol self. Wanneer die knol 'n sekere grootte bereik, ontwikkel dikwels 'n digte groep kleinere knolle deur die groei van verskeie okselknoppe; die knolle bly deels bedek deur die ou knoltunicae van die oorspronklike knol en elkeen vorm sy eie bogrondse spruit. Tydens antese is die blare dikwels kort en staan hulles laer as die blomme bo die grond uit; ná die blomtyd mag die blare verder verleng. Die blomme is helder violet met die segmente effens konkaaf, stomp tot halfskerp, en plat-spreidend in die middel van die dag. By die oopsplitsing van die doosvrugte buig die ses kleppe meestal terug, soos Stopp (1958) dit vir *S. leipoldtii* beskryf het.

S. longituba is 'n polimorfe spesie wat taamlik variabel is in: die lengte, breedte en kromming van die blare, die siliase op die blaarrande en die aantal vaatbundels; die grootte van die knol, sy diepte onder die grond, en die gladheid of skurfheid van sy tunicae; die blomgrootte, die kleur van die keel van die blomdek, in hoeverre die meeldrade uitgestoot is, die lengte van die stempels; en ook in die hoeveelheid bruin strepies (looistof-bevattende idioblaste) op die membraneuse rande van die skutblaar en skutblaartjie.

Verskillende vorms is as vier aparte spesies beskryf: die tipes van *S. filifolia* in BM en *S. leipoldtii* in BOL en K stem ooreen met dié van *S. longituba* behalwe vir die gladder knoltunicae, asook vir die besonder klein haarstompies op die blaarrande van *S. filifolia* (wat deur Baker as naak beskryf is), en vir die korter en minder uitgestote meeldrade van *S. leipoldtii*. Die tipe van *S. montana* in B verskil van dié van *S. longituba* in die opgekrulde blare, gladder knoltunicae en soms effens kleiner blomme. Daar is nou soveel kolleksies bekend met inter-mediêre kenmerke en met verskillende kombinasies van die bogenoemde variërende kenmerke, dat dit onmoontlik is om die vier spesies apart te behou.

Al vier die bogenoemde spesies word gekenmerk deur 'n blomdek met 'n geel keel. Kolleksies waarvan die blomdek nie geel in die keel is nie, maar wat verder die tipiese spesieskenmerke en -variasies toon, word hier as 'n aparte nuwe variëteit beskryf.

Baker (1876a en later) het *S. longituba* en *S. bicolor* as sinonieme beskou, waarskynlik "e descr.", sonder dat hy die tipe van *S. longituba* gesien het. Die

tipes van die twee spesies verskil egter nie net morfologies nie, maar ook in die anatomie van die knoltunicae en blare. Die tipe van *S. longituba* byvoorbeeld, het skurwe knoltunicae, 'n kenmerk wat by geen eksemplare van *S. bicolor* aangetref is nie, maar wel by sommige eksemplare van *S. filifolia*, veral uit die distrikte van Riversdale en Oudtshoorn. Verder is 'n palissade-agtige sklerenchiemlaag, wat 'n kenmerk is van die knoltunicae van *S. bicolor*, afwesig by die tipe van *S. longituba*; en die blare van *S. longituba* het minder vaatbundels as by *S. bicolor*. *S. longituba* hoort dus by die spesies onder bespreking en, daar dit die oudste naam is, is dit die geldige naam vir hierdie polimorfe groep.

a Var. *longituba*

S. longituba (Klatt) Kuntze 1898 p. 309 pro parte excl. syn. *S. bicolor* Baker. *Trichonema longitubum* Klatt 1865–66 p. 665 et 1895 p. 160 pro syn.; Baker 1876a p. 67 et 1877 p. 86 et 1892 p. 96 et 1896 p. 35 omnes pro syn.—holotypus *Mund & Maire 1101* in B.

S. filifolia Baker 1876a p. 67 et 1877 p. 86 et 1892 p. 96 et 1896 p. 35—holotypus *Bowie s.n.* in BM; Klatt 1882 p. 403 et 1895 p. 160; Lewis 1934 t. 547.

S. montana Klatt 1882 p. 403 et 1895 p. 160—holotypus: *Meyer ann.* 1869 in B; Baker 1892 p. 95 et 1896 p. 34.

S. leipoldtii L. Bolus 1931 p. 12—holotypus *Leipoldt BOL 19124* in BOL, isotypus in K; Stopp 1958 p. 38.

S. marlothii Schlechter ined, kom in B en PRE voor.

Icones: Flow. Pl. S. Afr. 14 t. 547 (1934); Rice & Compton, pl. 189 fig. 3; hierdie werk Fig. 14 h–j.

Hierdie variëteit word gekenmerk deur 'n blomdek met oranje tot geel keel en basisse van die segmente, en soms geel helmdrade, styl en stempels. Dit kom meer weswaarts voor en spreid na die suide tot by Riversdale, waar die blomdek-keel dikwels nie so intens geel is nie.

KAAP—3118 (VANRHYNSDORP). Top van Gifberg (DB): *Oliver 30.5.1965* (NBG), *Hall 3098* (NBG), *Barker 10210* (NBG).

3119 (CALVINIA). Top van Van Rhynspas (AC): *Salter 2142* (BOL, BM, K). Nieuwoudtville (AC): *Leipoldt 4246* (BOL). Naby Nieuwoudtville na Kareeboom (AC): *Lewis 5962* (NBG). 19 ml. W. van Calvinia (BC): *Salter 5370* (BOL, BM). Naby Grasberg (AC): *Lewis 5843* (NBG). Bloukrans 15 ml. S. van Calvinia (DB): *Hall NBG 227/58*. Keisersfontein: *Oliver 3391* (STE). Hantamberge (BC–BD) *Meyer ann.* 1869 (B, S).

3218 (CLANWILLIAM). Naby westelike voet van Pakhuispas (BB): *de Vos 2268* (STE).

3219 (WUPPERTHAL). Naby top van Pakhuispas (AA): *Stopp H1437* (BOL).

- 3220 (SUTHERLAND). Komsberg (DA-DB): *Marloth* 3932 (PRE, B) sub *R. marlothii* Schlecht. ined.
- 3318 (KAAPSTAD). Naby Malmesbury (BC): *Leipoldt* BOL 19124 (BOL, K), *Leipoldt* SAM 48352.
- 3319 (WORCESTER). Ca. 10 ml. N. van Karooport (BB): *Acocks* 14306 (PRE). Gouda (AC): *Leipoldt* BOL 20326.
- 3419 (CALEDON). Naby Botrivier (AA): *Lewis* 132 (SAM). Langs plaaspad 3 ml. O. van Botrivier (AA): *de Vos* 2271 (STE). 11 ml. W. van Caledon (AB): *Salter* 2400 (BOL).
- 3421 (RIVERSDALE). Twee-Kuilen: *Muir* 2394 (BOL, PRE). Heuwel naby Gouritzrivierbrug (DA/DB): *Muir* 2148 (BOL, PRE).
- CBS. sonder nadere vindplek: *Mund & Maire* 1101 (B). *Bowie* s.n. (BM).

b Var. *violacea* De Vos var. nov.

A typica fauce tubi perigonialis violacea vel alba, non lutea, distinguitur.

Holotypus: *de Vos* 2270 in STE.

Fig. 14 a–g.

Hierdie variëteit word van die tipiese onderskei in die pers of wit kleur in die keel van die blomdek, wat soms 'n pers lengte-aar vanaf elke blomdeksegment het; die helmtrade, styl en stempels is wit en die stempels lank en smal. Dit kom veral in die Klein-Karoo voor, met 'n uitloper na die aangrensende Groot-Karoo (Laingsburg) en na Bredasdorp se kant. Ongelukkig is daar sommige eksemplare waarby die kleur van die blomdekkeel onseker is, bv. *Acocks* 22399 (PRE) van Bredasdorp, *Bayliss* 2825 (NBG) van die Klein-Karoo tussen George en Mosselbaai, en *Ferguson* BOL 19497 (BOL, K) van Riversdale. By die volgende, egter, is dit seker dat die blomdekkeel nie geel is nie:

- KAAP—3320 (MONTAGU). Matjiesfontein (BC): *Marloth* 9925 (PRE), *Bolus* 13878 (BOL). Koppie 1 ml. NO. van Matjiesfontein (BA): *de Vos* 2266 (STE). Patatasrivier (AB): *Salter* 6058 (BOL). Voet van Witteberge (AD-BC): *Walgate* 252 (NBG). Whitehill (BA): *Compton* 13249 (NBG). Naby Barrydale (DC): *Taylor* 389 (BOL).
- 3321 (LADISMITH). Paardeberg, top van Huisrivierpas (BC): *Esterhuysen* 17112 (BOL, PRE). Springfontein: *Bolus* Junie 1930 (BOL). Derderivier, Klein-Karoo: *Muir* 3633 (BOL, PRE). 12 ml. NO. van Muiskraal na Van Wyksdorp (CD): *de Vos* 2270 (STE). Heuwels by Fisantekraal: *Muir* 3632.
- 3322 (OUDTSHOORN). Naby Oudtshoorn (CA): *Salter* 2339, 2339a (BOL). Renosterveld, Zebraskop-area: *Acocks* 20487 (PRE, K).
- 3420 (BREDASDORP). Ca. 15 myl van Bredasdorp na Swellendam (AC): *Van Niekerk* 437 (BOL). Kykoedie (AC): *Acocks* 22399 (STE).

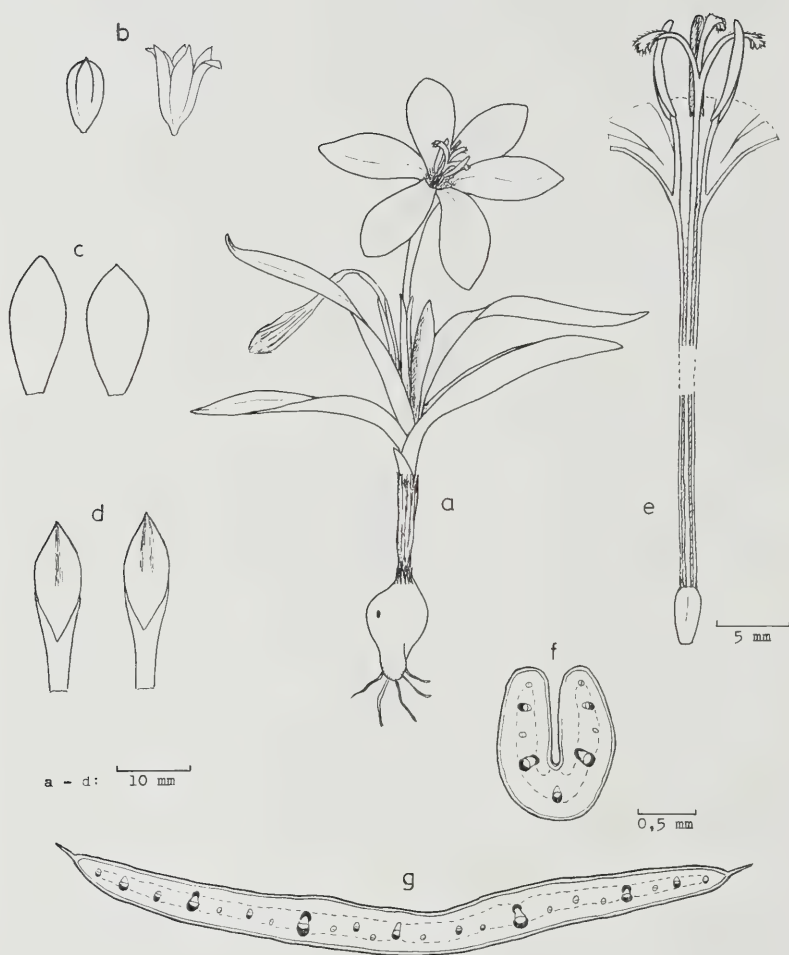


FIG. 15.

Syringodea derustensis (de Vos 2269): a, plant; b, vrug, geslote en oopgesplits; c, buitenste en binneste blomdeksegmente; d, skutblaar en skutblaartjie; e, blomdebuis, androecium en gynoecium; f, dwarsnee van 'n toegevoude blaar; g, dwarsnee van 'n plat blaar.

3421 (RIVERSDALE). Heuwels naby Riversdale (AA-AB): *Muir 2169* (BOL., PRE).

KLEIN-KAROO sonder nadere vindplek: *Bayliss 468* (PRE).

6. *S. derustensis* De Vos sp. nov.

Fig. 15, 7e.

Plantae 5–8 cm altae. *Cormus* breve ellipsoideus 10–15 mm longus 7–12 mm diam., crista basilari 4–6 mm lata ciliata aliquantum complanata, tunicis brunneis interdum scaberulis. *Caulis* perbrevis, collo foliorum veterum 10–25 mm longo obtectus. *Folia* 3–5 radicalia lanceolata ad linearia, complanata vel interdum conduplicata, saepe curvata, 30–60 mm longa 3–6 mm lata, marginibus ciliolatis, folia inferiora vaginis inapertis breviora et latiora quam superiora, apicibus obtusis saepe leviter tumidis vel subinvolutis. *Pedunculi* 4–5 mm longi obtecti. *Bractea* ca. 25 mm longa membranacea alba, saepe versus apicem zona mediana angusta viridi, supra dimidium tubi perigonalis attingens. *Bracteola* saepe versus apicem duabus zonis angustis viridibus. *Flores* 2–3, 45–60 mm longi basibus subterraneis. *Perigonium* hypocrateriforme limbo 30–40 mm diam.; *tubus perigonii* 25–35 mm longus minus quam 1 mm diam., apice 2 mm dilatato, extus albidus vel subviolaceus; *segmenta* obovata cuneata, plus minusve concava obtusa vel subobtusa 15–20 mm longa 8–10 mm lata dilute violacea vel interdum alba, segmenta interiora parum latiora quam exteriora. *Stamina* exserta; *filamenta* 5–6 mm longa alba, fere erecta; *antherae* 5–7 mm longae subpatentes vel apicibus incurvatis. *Ovarium* ca. 3 mm longum; *stylus* 33–38 mm longus albus; *stigmata* 4–5 mm longa conduplicata spatulata vel interdum apicibus subramosis, marginibus papillatis, apices antherarum attingentia vel parum inferiora. *Capsulae* turbinatae vel breve ellipsoideae vel interdum subglobosae, 6-valves dehiscentes in dimidio superiore; *semina* angulata ca. 1 mm diam. brunnea colliculata vel interdum pro parte foveolata.

Holotypus: de Vos 2269 in STE.

Plante 5–8 cm hoog. *Knol* kort-ellipsoïed, 10–15 mm hoog, 7–12 mm in deursnee, met 'n basale rif 4–6 mm breed en taamlik plat; tunicae bruin, soms skurf, met kort, fyn, parallelle fibrille op die basale rif. *Stingel* baie kort, verberg onder 'n kraag van ou bruin blaarbasisse 10–25 mm hoog. *Blare* 3–5, grondstandig, lansetvormig tot lineêr, plat of soms gekondupliseerd, dikwels gebuig, 30–60 mm lank, 3–6 mm breed, fyn gesilieerd met 'n ry kort wit hare op die rande, die punte stomp en dikwels effens opgeswel of ingerol, die onderste blare met geslote skedes en korter en breër as die boonstes. *Pedunculi* 4–5 mm lank, verberg. *Skutblaar* ca. 25 mm lank, membraneus, wit, dikwels met 'n smal groen mediane strokie na die top, reikend bo die helfte van die blomdekbuis. *Skutblaartjie* dikwels met twee smal groen strokies na die top. *Blomme* 2–3, 45–60

mm lank. *Blomdek* trompetvormig wanneer wyd oop, die soom 30–40 mm in deursnee; *blomdebuis* 25–35 mm lank, minder as 1 mm in deursnee, die top 2 mm in deursnee, byna wit tot pers buite; *segmente* omgekeerd-eiervormig, wigvormig aan die basis, effens konkaf, stomp of halfstomp, 15–20 mm lank, 8–10 mm breed, ligviolet (RHS 85B, C, D) tot soms wit, die binneste effens breër as die buitenste segmente. *Meeldrade* uitgestoot; *helmdrade* 5–6 mm lank, wit, byna regop; *helmknoppe* 5–7 mm lank, effens spreidend of met die punte ingekrom. *Vrugbeginsel* ca. 3 mm lank; *styl* 33–38 mm lank, wit; *stempels* 4–5 mm lank, gekondupliseerd, spatelvormig of soms effens vertak aan die toppe, met papillae op die rande, reikend tot die helmknoppe of effens laer. *Doosvrugte* tolvormig, ellipsoïed of soms byna bolrond, 5–10 mm lank, met 'n smal pseudo-pedisellate basis, oopsplitsend met ses kleppe in die boonste helfte; *sade* hoekig, ca. 1 mm in deursnee, bruin, fyn kollikulaat of soms deels foveolaat. *Chromosoomgetal* $2n = 12$.

KAAP—3322 (OUDTSHOORN). Drinkrivier naby De Rust, op 'n klipperige koppie (BC): *de Vos* 2269 (STE). Naby De Rust, op P. M. K. le Roux se plaas (BC): *Dahlstrand* 2056 (PRE).

Blomperiode Mei tot Junie.

Hierdie nuwe spesie is in 1971 deur K. Dahlstrand ontdek en kom sover bekend slegs op een heuwel voor op 'n plaas 'n paar myl oos van De Rust, waar dit baie algemeen is. Teen die aand wanneer die blomme begin sluit, word hulle tregtervormig en lyk hulle baie soos krokusse. Die stempels van sommige plante is effens vertak, ook 'n kenmerk van *Crocus*; maar die knol, blare, vrug, ens. is tipies van *Syringodea*. Die spesie is moontlik naaste verwant aan *S. longituba*; onder andere is die anatomie van hul knoltunicae eenders en die testastruktuur byna dieselfde.

S. derustensis verskil van die ander *syringodeas* in sy breë, plat of effens oorlans gevoude blare. (Dit is nie dieselfde as *S. latifolia* nie wat geblyk het 'n *Hesperantha* te wees, met unifasiale blare).

Die doosvrugte splits met natwording in hul boonste helftes oop met ses kleppe wat eers regop staan. Na 'n tweede en verdere natwording buig die kleppe na buite, omdat die buitenste vrugwandlae los raak van die endokarp en dan nie meer as weerstand dien nie. Die vrugsteel verleng nie en slegs die top van die vrug verskyn bo die grond. Die kollikulate ornamentasie van die testa word deur bolvormige epidermisselle veroorsaak (Fig. 8e).

7. *S. saxatilis* De Vos sp. nov.

Fig. 16.

Plantae 4–8 cm altae. *Cormus* obovoideus 5–12 mm diam., basi obliquus crista parva ciliata, tunicis rigidis laevibus brunneis, apice dentibus acuminatis praedito. *Caulis* perbrevis collo foliorum veterum obtectus. *Folium* 1 (interdum

apparente 2) radicale, teres glabrum ubi juvine, sulco adaxiali marginibus ciliolatis ubi florens, falcatum 50–120 mm longum, 1,5–2,5 mm latum. *Pedunculus* 3 mm longus obtectus. *Bractea* 12–15 mm longa membranacea alba acuta, stria brevi viridi mediana versus apicem, infra dimidium vel prope apicem tubi perigonalis attingens. *Bracteola* striis duabus viridibus versus apicem. *Flos* 1 (interdum 2) 25–35 mm longus basi subterraneo. *Perigonium* aliquantum hypocrateriforme limbo 20–40 mm diam.; *tubus perigonii* 15–20 mm longus ca. 1 mm diam., apice ca. 3 mm dilatato, extus albidus; *segmenta* obovata concava obtusa ad subacuta 10–20 mm longa 5–8 mm lata malvino-rosea vel dilute violacea interdum purpureonervia, in fauce violacea; segmenta exteriora a dorso sordide purpurea vel albida, basi purpureonervia. *Stamina* exserta; *filamenta* 5–7 mm longa erecta alba; *antherae* 3–5 mm longae pertenuis apicibus incurvis. *Ovarium* 2–3 mm longum; *stylus* 20–25 mm longus albus; *stigmata* 4–5 mm longa conduplicata apicibus spatulatis, sub apices vel supra apices antherarum attingentia. *Capsulae* turbinatae 6–10 mm longae, dehiscentes 6-valves in dimidio superiore; *semina* fere globosa vel subangulata atra 1 mm diam. colliculata vel interdum pro parte foveolata.

Holotypus: de Vos 2264 in STE.

Plante 4–8 mm hoog. *Knol* omgekeerd-eiervormig, 5–12 mm in deursnee, skuins by die basis met 'n basale riffie 5–7 mm breed; tunicae hard, glad, bruin of donkerbruin, met fyn parallelle fibrille op die basale riffie en skerp tande bo. *Stingel* baie kort, verberg onder 'n kraag van ou blaarbasisse 20–30 mm hoog. *Blaar* een, soms skynbaar 2, grondstandig, tereet en naak in die jong toestand, by blommende plante met 'n adaksiale groef in die onderste gedeelte, fyn gesilieerd op die rande, tereet na bo, sterk gebuig, spreidend, 50–120 mm lank, 1,5–2,5 mm breed. *Pedunculus* 3 mm lank, verberg. *Skutblaar* 12–15 mm lank, membraneus, wit, met 'n kort groen mediane strokie naby die top, skerp, reikend onder die middel van die blomdebuis tot naby sy top. *Skutblaartjie* met twee smal groen lengtestrokies na die top. *Blomme* meestal 1, soms 2, 25–35 mm lank. *Blomdek* byna trompetvormig, met die soom 20–40 mm in deursnee; *blomdebuis* 15–20 mm lank, ca. 1 mm in deursnee en 3 mm aan die top, witterig buite; *segmente* omgekeerd-eiervormig, konkaf, stomp tot half-skerp, 10–20 mm lank, 5–8 mm breed, pienk-pers of ligviolet (RHS 75A. 82C), soms met dowwe pers are, violet in die keel van die buis; buitenste segmente perserig of witterig aan die buitekant met effense pers are na die basis. *Meeldrade* uitgestoot; *helmdrade* 5–7 mm lank, wit, regop; *helmknoppe* 3–5 mm lank, baie smal, die punte na binne gebuig. *Vrugbeginsel* 2–3 mm lank; *styl* 20–25 mm lank, wit; *stempels* 4–5 mm lank, dubbelgevou, spatelvormig aan die toppe, reikend tot bo of onder die helmknoppe. *Doosvrugte* tolvormig, 6–10 mm lank, smal aan die basis, oopsplitsend aan die top met ses kleppe; *sade* byna

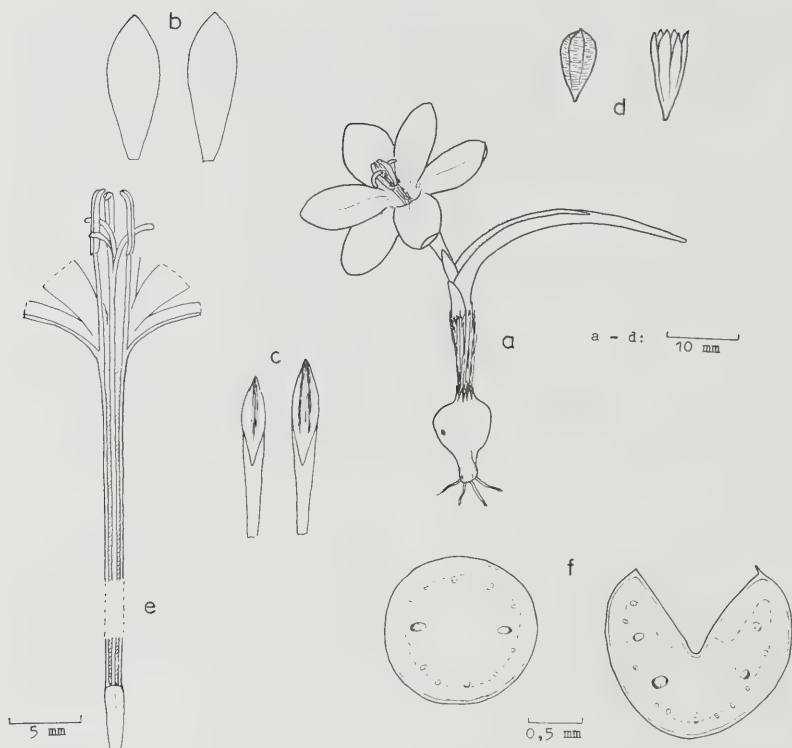


FIG. 16.

Syringodea saxatilis (de Vos 2264): a, plant; b, buitenste en binneste blomdeksegmente; c, skutblaar en skutblaartjie; d, vrug, geslote en oorgespleet; e, blomdekbuis, androecium en gynoecium; f, deursnee deur die unifasiale blaar van 'n jong plant en die bifasiale blaar van 'n bloeiende plant.

bolronde of effens hoekig, swart, 1 mm in deursnee, fyn kollikulaat of soms deels foveolaat. *Chromosoomgetal* $2n = 12$.

KAAP—3321 (LADISMITH). Dorpsmeent 300 m van die wynkelders, tussen sukkulente (AD): *Stayner* 30.5.71 (NBG), *de Vos* 2264 (STE).

Blomtyd Mei tot Junie.

Hierdie nuwe spesie is in 1971 ontdek en kom sover bekend slegs op een heuwel tussen regop kliprifies in die Klein-Karoo by Ladismith voor, waar dit taamlik algemeen is. Dit word gekenmerk deur sy enkele, platspreidende, gebuigde, taamlik opgeswelde, loofblaar. By jong plante wat nog nie geblom

het nie, is die blaar tereet; by blomende plante het dit 'n adaksiale groef, met slegs die boonste deel tereet (Fig. 16f).

S. saxatilis verskil van *S. unifolia*, wat ook een loofblaar het, in sy knol wat die tipiese bou van die subgenus *Syringodea* het, in sy overdeelde stempels, hicrochastiese vrug wat met ses kleppe oopsplits, en in blaarstruktuur—dit is sonder 'n kollenchiemstrook. Die twee spesies is nie naverwant nie, en die reduksie tot 'n enkele blaar moes tweemaal onafhanklik in die genus plaasgevind het.

B. Subgenus RHIPIDOPSIS De Vos subgen. nov.

Cormus verticale complanatus sublentiformis, crista verticali late flabelliformi semicirculari. *Folium* plerumque unum, aliquantum subsucculentum. *Stigmata* multifissa. *Capsula* xerochastica trivalvis loculicidale dehiscens apice. Typus subgeneris: *S. unifolia* Goldblatt.

Knol vertikaal afgeplat, byna lensvormig, met 'n vertikale, breed-waaier-vormige, halfsirkelvormige rif met fyn parallelle fibrille. *Blaar* meestal een, effens opgeswel, met subepidermale kleurlose parenchiemstroke teenoor die vier groot vaatbundels en kollenchiem in die adaksiale groef (dwaarsnee, Fig. 5b, 17e, f). *Stempels* veeldelig. *Doosvrug* xerochasties, hokspletig aan die top met drie kleppe. *Chromosoomgetal* $2n = 22$.

Hierdie klein monotipiese subgenus verskil van die subgenus *Syringodea* (1) morfologies in sy anderse knolvorm, veeldelige stempels en xerochastiese vrugte; (2) anatomies in die eienaardige sklereïede (platysklereïede, Fig. 4) van die knoltunicae, in die blare met kleurlose parenchiem- en kollenchiemstroke en sonder tannien, en in die breër, gerimpeld-retikulate saadhuide; en (3) in die chromosoomgetal.

Die enkele spesie toon egter soveel tipiese *Syringodea*-kenmerke dat dit in die genus behou is; bv. die lang blomdebuis met ondergronds verbergde vrugbeginsel, uitgestote meeldrade en stempels, tipiese skutblaar en skutblaartjie, bloeiwyse, kort stingel en pedunculus. Dit is meer gespesialiseerd as die spesies van die tipiese subgenus, maar dit is onmoontlik om te sê watter van hulle sy naaste verwante is. Die verdeelde styltakke herinner aan dié van *Crocus*, maar die knol en blare verskil van hierdie genus van die noordelike halfrond.

Die naam *Rhipidopsis* dui op die waaier-vormige knoltunicae.

8. *Syringodea unifolia* Goldblatt in Flow. Pl. Afr. t. 1638 (1971b) et 1971a p. 394.

S. rosea Klatt 1882 p. 403 excl. syn., et 1895 p. 160; Baker 1892 p. 96 et 1896 p. 35; Goldblatt 1971a p. 394 pro syn.

Icon. Flow. Pl. Afr. t. 1638; hierdie werk Fig. 17, 1f, 7f.

Holotipe: Stayner s.n. NBG 87602; isotype in BOL.

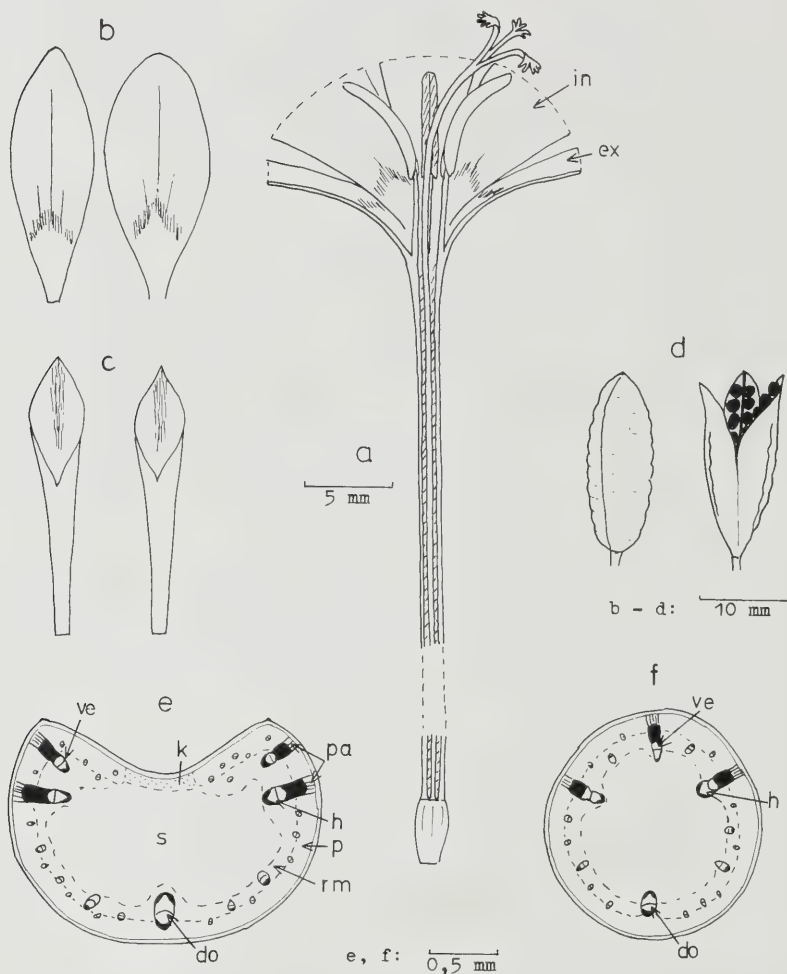


FIG. 17.

Syringodea unifolia (de Vos 2267): a, perigoniumbuis, androecium en gynoecium: ex, buitenste blomdeksegment; in, binneste blomdeksegment; b, buitenste en binneste blomdeksegmente; c, skutblaar en skutblaartjie; d, vrug, geslote en oopgesplit; e, dwarsnee deur die bifasiale blaar van 'n volwasse plant; f, dwarsnee deur die unifasiale blaar van 'n plant wat nog nie blom nie: do, dorsale vaatbundel; h, hoof-laterale bundel; k, kollenchium; p, palissade; pa, kleurlose subepidermale parenchiem; rm, rondsellige mesofil; s, spasie; ve, ventrale bundel (randbundels).

Plante 5–12 cm hoog, soms tot 20 cm. *Knol* vertikaal afgeplat, byna lensvormig, 10–20 mm, soms tot 25 mm breed, met 'n breë waaivormige vertikale rif tussen die twee kante; tunicae hard, glad, bruin, met fyn parallelle fibrille op die rif, en 10–25 mm lange skerp fibrille aan die top. *Stingel* 10–20 mm lank, verberg onder die lang fibrille aan die top van die knol. *Basale skedes* 1–2, membraneus. *Loofblare* een, selde twee, meestal sekelvormig, opgeswel, subtereet, maar met 'n adaksiale lengtegroef, die top dikwels tereet, 50–150 mm lank, 1,5–3 mm of soms tot 3,5 mm breed, naak of dikwels fyn gesilieerd op die groefrande; by jong plante tereet en unifasiaal. *Pedunculus* 5–20 mm lank, verberg. *Skutblaar* en *skutblaartjie* 25–40 mm lank, smal-eiervormig tot lineêr, skerp, tot bo die middel geslote, grotendeels membraneus en wit, maar groenerig in die middel van die boonste deel, reikend bo die helfte tot naby die top van die blomdekbuis. *Blomme* 1–4, 40–60 mm lank. *Blomdek* byna trompetvormig, met die soom 30–65 mm in deursnee; *blomdekbuis* 30–40 mm, soms tot byna 50 mm lank, ca. 1 mm in deursnee, aan die top 3 mm wyd, lig van kleur; *segmente* omgekeerd-eiervormig, konkaaf, stomp, 15–30 mm lank, 7–14 mm breed, bloupers (RHS 88C, 91B, C) soms wit, dikwels oranje-geel aan die basis wat mag verbleik in ou blomme, met 'n smal donker-pers strook bo die geel, en 'n paar donker are; buitenste segmente bontpers aan die buitekant, met fyn donker merkies en 'n ligte ovaal kol in die middel. *Meeldrade* uitgestoot; *helmdrade* 6–9 mm lank, regop, wit of liggeel, soms fynbehaard aan die basis; *helmknoppe* 5–10 mm lank, effens spreidend, oranje-geel. *Vrugbeginsel* ca. 3 mm lank; *styl* filiform, 45–65 mm lank, wit, soms gebuig, met styltakke 5 mm lank, uitgerafel en veeldelig aan die toppe; *stempels* talryk, reikend tot die helmknoppe of hoër. *Doosvrugte* effens driekantig-ellipsoïed, tot 20 mm lank, met 'n hard-membraneuse perikarp, hokspletig aan die top met drie kleppe, op 'n pedunculus wat tot 20 mm verleng; *sade* bolrond, byna 2 mm in deursnee, swart, met 'n gerimpeld-retikulate testa. *Chromosoomgetal* $2n = 22$.

KAAP—3119 (CALVINIA). Hantamberge (BC–BD): Meyer s.n. ann. 1869 (B). 3220 (SUTHERLAND). Top van Verlatekloof (DA): Hall 205 (NBG), de Vos 2217 (STE). Sutherland (BC): Marloth 9799 (PRE). Top van Komsbergpas (DA): de Vos 2267.

3319 (WORCESTER). Matroosberg oorkant die hut (BC): Stayner NBG 90073, 87602, BOL 30678, 3 ml. N. van Matroosberghut: Stayner NBG 87601. Top van Heksrivierpas langs Koo-pad (BD): Stayner NBG 87594. Naby Matroosbergstasie (BD): Stayner NBG 90073.

Blomtyd Mei tot Junie.

S. unifolia kom voor op berge en bergplato's in drie binnelandse distrikte van Wes- en Suidwes-Kaapland (Fig. 10). Dit word maklik van ander syringodeas uitgeken aan sy platterige waaivormige knol, meestal een, opgeswelde, byna

terete blaar, en blomme met talryke stempels. By blommende plante ontwikkel die blaar 'n adaksiale groef. By ouer blomme buig die styl effens sodat sy top nie meer sentraal staan nie. Die spesie verskil ook anatomies en sitologies van ander *Syringodeas*—sien die bespreking by die subgenus *Rhipidopsis*.

S. unifolia is deur Klatt (1882) beskryf as *S. rosea*. Hy het egter *R. rosea* (L.) Ecklon as sinoniem bygevoeg, tesame met die tipe van laasgenoemde wat 'n egte *Romulea* is. Dit het die spesie sonder geldige naam gelaat, wat Goldblatt reggestel het (1971b).

UITGESLUIE SPESIES

Syringodea latifolia Klatt 1882 p. 403. Dit is *Hesperantha latifolia* (Klatt) De Vos comb. nov.: non Steudel 1841 nom. nud. Die holotipe, *Drège 2633* in B, bestaan uit twee klein flenters, maar die isotipe in P is in 'n uitstekende toestand. Volgens die beskrywings staan dit naaste aan *H. pearsonii* Foster 1948 p. 21, die tipe waarvan ek nie gesien het nie; dit mag 'n sinoniem van *H. latifolia* wees.

S. linifolia E. P. Phillips 1913 p. 125 is nader verwant aan *Tritonia* as aan *Syringodea*. 'n Nuwe genus moet waarskynlik hiervoor gemaak word.

S. luteo-nigra Baker 1897 p. 281 is *Romulea macowanii* Baker 1876b, p. 236.

S. minuta Klatt 1882 p. 403. Klatt gee hierby geen sitasie aan nie, behalwe die sinoniem *Ixia minuta* L. f. Suppl. p. 92, . . ., Thunberg Fl. Cap. p. 216 en Diss. de *Ixia* p. 6 ex parte. Dit is *Pauridia minuta* (L. f.) Dur. & Schinz—sien ook Baker 1896 p. 36 en Brown 1928 p. 49.

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Die direkteure en kurators van die herbaria, B, BM, G, K, P, S, BOL, GRA, NBG, PRE, SAM en STE, word hartlik bedank vir die uitleen van hul tipe- en ander *Syringodea*-materiaal waarsonder hierdie ondersoek nie voltooi sou kon word nie. Ek is ook dank verskuldig aan die W.N.N.R. en mev. M. Hengstberger van die Afdeling Elektronmikroskopie van die Fisiese Navorsingslaboratorium wat die skandeer-elektronmikroskoopwerk gedoen het, aan die Universiteit van Stellenbosch vir 'n reistoelaag om vars materiaal te versamel, en aan die tegniese personeel van die Plantkunde-departement wat op velerlei maniere gehelp het. Laastens gaan my hartlike dank aan prof. Elsabe Malan, mej. A. Uys en mnre. E. Oliver van Stellenbosch, mej. W. F. Barker van Kirstenbosch, mnre. C. van Reenen van Ladismith en K. Dahlstrand van Port Elizabeth, wat almal behulpzaam was met die versameling van vars materiaal, en aan prof. P. G. Jordaan wat die manuskrip deurgelees het.

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BOOK REVIEWS

ENDOGENOUS PLANT GROWTH SUBSTANCES by T. A. Hill with pp. 66. Edward Arnold Ltd., London, 1973. South African Price R1,85.

This publication, No. 40 in the series "Studies in Biology" sponsored by the Institute of Biology, satisfies an urgent need for a modern general introduction to plant hormones. This is a field of botany where there has been remarkable developments in recent years and in which ideas are still changing with, to many, confusing rapidity. Although it was written primarily with first year university students in mind, this book will undoubtedly be of value to mature and lay botanists who want to brush up their knowledge of plant physiology. As with most of the previous issues in this excellent and useful series, the format is attractive and the style concise and direct.

The book opens with a completely adequate treatment of the necessary historical and chemical background. This is followed by a consideration of the methods of extraction and biological and physico-chemical assay. The instructions given in Chapter 6, on the handling of growth substances and the conduct of simple experiments, will be much appreciated by biology teachers. The remainder of the book discusses the roles of auxins, gibberellins, cytokinins, abscisic acid and ethylene in the growth and development of plants. Table 1, is valuable in that it summarises the effects of exogenous, i.e. applied, growth substances and indicates the extent to which the same effects can be attributed to endogenous hormones.

Although the author indicates that there are unresolved problems, nevertheless it must be pointed out that ideas on the role of specific substances and on the underlying mechanisms of hormonal control will probably change rapidly in the near future. Our knowledge of ethylene, abscisic acid and the cytokinins has already increased considerably since the writing of this book was undertaken. It is for, example, debatable whether abscisic acid affects any other growth phenomena than the opening and closing of stomata, and ethylene is more and more assuming the role of the primary growth factor. Nevertheless, in describing in simple terms the general principles of hormone physiology and the internal control of plant growth, this book is strongly recommended.

J. VAN STADEN

MICROAUTORADIOGRAPHY AND ELECTRON PROBE ANALYSIS edited by U. Lüttge, with pp. iii + 242, 78 figs. Berlin, Heidelberg, New York: Springer-Verlag, 1972. Soft cover, U.S. \$14.60.

An extremely useful soft-cover reference work has been published by Springer-Verlag on microautoradiographic and electron-probe analytical techniques. The overall appearance of the book is neat, its size is compact enough for daily desk and laboratory use without being too small as to exclude a full and comprehensive coverage of the subject. The book should have appeal particularly to those researchers and post-graduate students in South Africa interested in the botanical applications of microautoradiography in respect both of light and electron microscopy. Inclusion of Electron Probe Analysis in the title of the book is slightly misleading since only one-seventh of it is devoted to a discussion of this technique.

The bibliography in all the chapters seems very well balanced containing references to earlier work as well as to most recent development in the respective fields. The index is excellent.

The book should be of use to anyone working actively in the field of morphogenesis since the review of the techniques is comprehensive and the diagrams and photomicrographs are of very good quality.

CHRIS H. BORNMAN

THE ALPINE VEGETATION OF THE LESOTHO DRakensBERG: A STUDY IN QUANTITATIVE FLORISTICS AT OXBOW

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ABSTRACT

A quantitative survey of the botanical composition and basal cover of portion of the Madibamatso (Oxbow) Dam catchment at 2 800 m in the Lesotho Drakensberg, indicates that the vegetation has an average basal cover of 29%, is temperate in character and comprises 126 species. *Gramineae* (18 spp.) make up 65% of the basal cover and *Helichrysum* (12 spp.) makes up 8%. Of the total cover, 70.2% is comprised of only 10 species. Dominant grasses are *Danthonia*, *Harpechloa*, *Festuca*, *Poa*, *Themeda* and *Eragrostis* in that order. Of the macchia, *Erica* (5 spp.) is the most abundant. Tall sclerophyllous genera such as *Cliffortia* and *Anthospermum* are absent. *Chrysocoma tenuifolia* and *Pentzia cooperi* dominate overgrazed sites. Of the families present *Compositae* (36 spp.), *Gramineae* (23 spp.) and *Scrophulariaceae* (10 spp.) are the best represented.

UITTREKSEL

DIE ALPYNSE PLANTEGROEI VAN DIE LESOTHO DRakensBERG: 'N KWANTITATIEWE FLORISTIESE STUDIE TE OXBOW

'n Kwantitatiewe opname van die botaniese komposisie en basale bedekking van 66 vk. km van die opvanggebied van die beplande Madibamatso (Oxbow) dam teen 2 800 m in die Lesotho Drakensberg is onderneem. Resultate toon dat die basale bedekking gemiddeld 29% is, dat die plantegroei gemagtig in karakter is en dat dit 126 spesies insluit. *Gramineae* (18 spp.) maak 65% van die bedekking uit en *Helichrysum* (12 spp.) maak 8% uit. Van die totale bedekking is slegs 10 soorte verantwoordelik vir 70.2% van die bedekking. Dominante grasse is *Danthonia*, *Harpechloa*, *Festuca*, *Poa*, *Themeda* en *Eragrostis* in daardie volgorde. Van die fynbossoorte is *Erica* (5 spp.) die mees volop. Hoë fynbostipes soos *Cliffortia* en *Anthospermum* is afwesig. *Chrysocoma tenuifolia* en *Pentzia cooperi* is volop naby veeposte. Van die families teenwoordig, het *Compositae* 36 spp., *Gramineae* 23 spp. en *Scrophulariaceae* 10 spp.

INTRODUCTION

The vegetation of the eastern section of the Drakensberg has been described in varying depths by a number of botanists (Thode, 1894; Galpin, 1909; Bews, 1917; Markotter, 1930; Staples and Hudson, 1938; Schelpe, 1946; West, 1951; Acocks, 1953; Van Zinderen Bakker, 1955; Killick, 1963; Edwards, 1963; and Jacot-Guillarmod, 1963). Unfortunately many of these authors either only described certain communities, often in terms of dominants only, or limited their investigations to generalized sketches of the flora. The most detailed descriptions

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are those of Schelpe (1946), Killick (1963) and Edwards (1963). In the Maluti section of the Drakensberg, the comprehensive description of the Leribe Plateau as published by Phillips (1917) on the basis of Madame Dieterlen's collections is a particularly useful contribution to present knowledge of the mountain flora.

STUDY AREA AND PROCEDURE

The present study was undertaken in the Tshlanyane valley of the Madibamatso catchment above the proposed Oxbow Dam site in the extreme northern corner of Lesotho during the summer of 1969/70. The study area comprises 66 sq. km. of steep treeless alpine grassland situated between 2 590 m and 3 050 m (see Fig. 1). The soil is derived from Drakensberg basalt, the rainfall averages 1 272 mm and absolute maximum and minimum temperatures are 22°C and 2°C

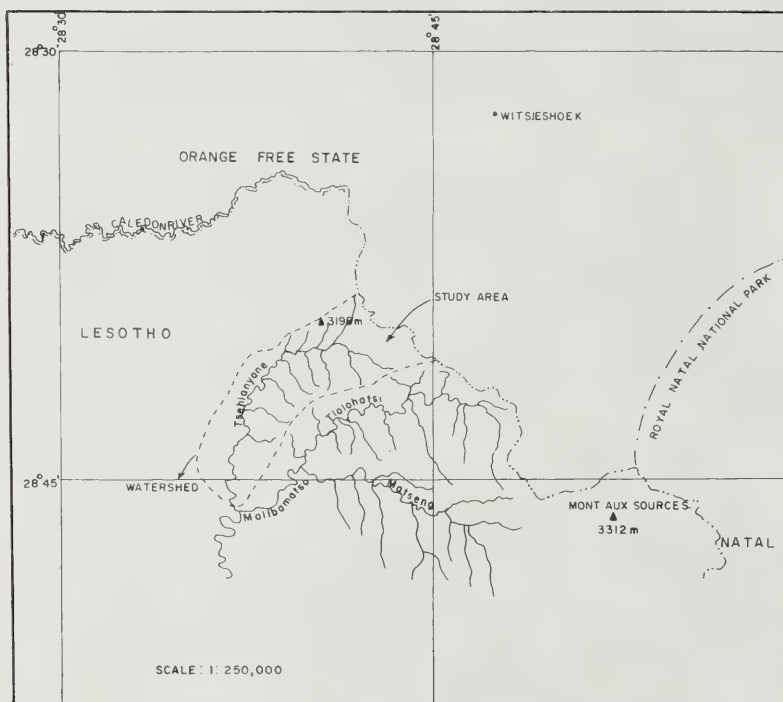


FIG. 1.
Geographic situation of the Tshlanyane Catchment.



FIG. 2.
Portion of the Tsehlanyane Valley.

in summer, with winter equivalents of 13°C and -13°C . The area is regularly snow-clad during winter and snow may persist for several months particularly on southern slopes. (Fig. 2.)

The quantitative survey was based on 102 sampling sites each 35 m^2 in size. The position of these sites was determined by superimposing a grid on enlarged aerial photographs (1:15 000) of the Tsehlanyane valley. Survey data is based on a sample of 500 points taken with a single aluminium wheel, using a reading spoke of 3 mm diameter, with points every 1.5 m. Strikes on living plants at soil level were recorded as defined by Tidmarsh and Havenga (1953). Nearest plant data were recorded in the absence of a strike. Plots were permanently marked as described by Herbst (1971). Details of techniques applied and results obtained in investigations into the quantitative relationships between habitat factors (soil properties, slope, altitude and aspect) and vegetation attributes (botanical composition and basal cover) have been reported elsewhere (Herbst and Roberts, 1974).

Following Phillips' (1959) proposal for the calculation of an "Importance Value" for each species, results have been based on the number of strikes plus the number of times each species was recorded as nearest plant, giving the percentage contribution of each species to botanical composition.

RESULTS

The plant collection from the survey area as a whole comprized 126 species of higher plants, of which 80 were recorded within the sampling sites. All specimens were identified by the National Herbarium, Pretoria and duplicate specimens are lodged in the Department of Pasture Science, University of the Orange Free State, Bloemfontein.

The flora is a simple one in terms of number of species and formations, compared with the nearby vegetation at Golden Gate (460 spp.) and Thaba

TABLE 1.

Contribution of species to the vegetation of the Tsehlanyane Valley, based on basal cover and nearest plant records (56 000 points, 102 sites).

Plant species	% Contribution (Basal cover & Nearest Plant)
<i>GRAMINEAE</i>	
<i>Danthonia disticha</i>	22,6
<i>Harpechloa falx</i>	7,4
<i>Festuca caprina</i>	6,3
<i>Poa annua</i>	4,6
<i>Themeda triandra</i>	4,2
<i>Eragrostis caesia</i>	3,9
<i>Pentaschistis galpinii</i> }	5,5
<i>P. jugorum</i> }	
<i>P. setifolia</i> }	
<i>Aristida junciformis</i>	2,9
<i>Danthonia drakensbergensis</i>	2,6
<i>Koeleria cristata</i>	1,5
<i>Helictotrichon turgidulum</i>	0,6
<i>Agrostis barbuligera</i>	0,5
<i>Anthoxanthum dregeanum</i>	—
<i>Bromus speciosus</i>	0,5
<i>Festuca</i> spp. }	
<i>Pennisetum thunbergii</i> }	
<i>Agrostis lachnantha</i> }	
TOTAL FOR GRASSES	63,0
<i>HELICHRYSUMS</i>	
<i>Helichrysum flanaganii</i>	3,5
<i>H. subglomeratum</i>	2,3
<i>H. infaustum</i>	0,9
<i>H. marginatum</i>	0,9
<i>H. trilineatum</i>	0,5
<i>H. squamosum</i> }	0,3
<i>H. setosum</i> }	
<i>H. adenocarpum</i> }	
<i>H. kuntzei</i> }	
<i>H. odoratissimum</i> }	
<i>H. scapiforme</i> }	
<i>H. sessile</i> }	
TOTAL FOR HELICHRYSUMS	8,4

MACCHIA, SEGDES and HERBS

<i>Scirpus falsus</i>	10,8
<i>Oxalis depressa</i>	3,4
<i>Cyperus schlechteri</i>	1,7
<i>Scirpus ficinioides</i>	1,4
<i>Fimbristylis exilis</i>	0,9
<i>Kniphofia caulescens</i>	0,7
<i>Cenia microglossa</i>	0,6
<i>Senecio othonnaeflorus</i>	0,6
<i>Gazania</i> sp.	0,5
<i>Marulia flanaganii</i>	0,5
<i>Geum capense</i>	0,5
<i>Chryscoma tenuifolia</i>	0,5
<i>Anthospermum rigidum</i>	
<i>Athanasia thodei</i>	
<i>Crassula setulosum</i>	
<i>C. rubescens</i>	
<i>C. sarcocaulis</i>	
<i>C. cooperi</i>	
<i>Dianthus micropetalus</i>	
<i>D. basuticus</i>	
<i>Carex clavata</i>	
<i>Euryops montanus</i>	
<i>Erica dominans</i>	
<i>E. frigida</i>	
<i>E. algida</i>	
<i>E. sp. (No. 3526)</i>	
<i>Geranium incanum</i>	
<i>Berkheya</i> sp. (No. 5832)	
<i>Senecio achilleaeifolius</i>	4,2
<i>S. inaequidens</i>	
<i>S. concolor</i>	
<i>Mohria cafforum</i>	
<i>Pellae quadripinata</i>	
<i>Fimbristylis exilis</i>	
<i>Dierama</i> sp.	
<i>Psammotropha alternifolia</i>	
<i>Lotononis galpinii</i>	
<i>Pentzia cooperi</i>	
<i>Zaluzianskya alpestris</i>	
<i>Scabiosa columbaria</i>	
<i>Wahlenbergia caledonica</i>	
<i>Athrixia fontana</i>	
<i>Felicia pinnatifida</i>	
<i>Hebenstreitia dentata</i>	
<i>Eumorphia sericea</i>	2,2
"Unknown herbs"	
TOTAL FOR MACCHIA	28,6
	100,0

'Nchu (448 spp.) as reported by Roberts (1966 and 1969). Killick's (1963) collection in the Cathedral Peak area, covering an altitudinal difference of 1 500 m includes 907 species of which 305 are monocotyledons and 556 are dicotyledons.

The contributions of the 80 species recorded in the quadrats at Tsehlanyane are summarized in Table 1. With the exception of *Poa annua*, the relative im-

portance value of the more abundant species coincides with the order in which these species are ranked according to basal cover (see Herbst and Roberts, 1974).

It may be seen from Table 1 that the grasses (18 spp.) make up 65% of the vegetative cover of the study area, while *Helichrysum* (12 spp.) makes up 8%. It is also shown that 70,2% of the cover is made up of only 10 species.

No quantitative surveys in the alpine zone of the Drakensberg are available for comparison, but whereas this study exposes *Danthonia*, *Harpechloa*, *Festuca*, *Poa*, *Themeda* and *Eragrostis caesia* as the most important dominants, Killick's (1963) point surveys at Cathedral Peak (2 000 m) record *Themeda*, *Trachypogon*, *Tristachya*, *Harpechloa* and *Heteropogon* as the dominants. At Cathedral Peak *Helichrysums* only contributed 0,1% to basal cover, as compared with 8,4% at Tsehlanyane. It is significant to note that the same number of species of grasses (18) recorded in the point surveys are present in these two survey areas; although Killick states that *Themeda* "drops out at about 2 835 m" and "appears again, frequently in pure stands above 2 440 m on the Lesotho side of the escarpment".

Comparison of the lists of dominants at Cathedral Peak and Tsehlanyane clearly indicates an increasing temperate affinity not only of the grasses, but also of the herbs from 2 000 m to 2 750 m. Dominants of the macchia ("fynbos") vegetation as listed by Acocks (1953) for the temperate regions of the Cape which occur at Tsehlanyane, include *Erica*, *Pelargonium*, *Satyrium*, *Euryops*, *Helichrysum*, *Pentzia*, *Senecio*, *Passerina*, *Muraltia* and *Moraea*. Of the sclerophyllous bush types present at Tsehlanyane, the genus *Erica* is the most abundant, with *E. dominans*, *E. frigida* and *E. algida* important. Other sclerophyllous bush types are *Passerina*, *Euryops* and *Athanasia*. The taller types such as *Cliffortia* and *Anthospermum* which are common in macchia formations at mid-altitudes (Roberts, 1961, 1963, 1966a) are absent from the Tsehlanyane vegetation, but *Chrysocoma tenuifolia* and *Pentzia cooperi* are present in localized overgrazed sites near cattle posts.

TABLE 2.
Predominant families at Tsehlanyane, Cathedral Peak(1) and Leribe Plateau(2).

	No. species at each site		
	Tsehlanyane	Cathedral Peak	Leribe Plateau
Compositae	36	154	286
Gramineae	23	100	146
Scrophulariaceae	10	46	86
Crassulaceae	8	14	35
Cyperaceae	6	46	75
Ericaceae	5	20	20
Liliaceae	2	47	101
Iridaceae	2	32	36
Orchidaceae	2	44	89
Leguminosae	2	27	95

(1. Killick, 1963; 2. Phillips, 1917).

Both the simplicity of the vegetation and the predominant families at Tsehlanyane, relative to Cathedral Peak and Leribe Plateau are indicated in Table 2.

Whereas *Compositae* and *Gramineae* are the best represented families at all the above areas, *Liliaceae* and *Orchidaceae* appear to lose significance with altitude, while *Scrophulariaceae* are important at all three localities. Within the *Gramineae* it is noteworthy that whereas Killick (1963) reports the prominent grasses between 2 600 m and 2 750 m to include *Trachypogon* and *Tristachya*, neither of these was recorded at a similar altitude and on a similar soil at Tsehlanyane. Acocks' (1953) description of this "*Themeda*—*Festuca* Alpine Veld" (Type 58) has been criticized by Killick (1963) who maintains that the temperate species become dominant "to the complete exclusion of *Themeda*" in the summit vegetation. The present quantitative study demonstrates that *Themeda* is more abundant than thirteen other grass species, most of which are temperate.

It is noteworthy that many of the families which occur at the altitude of the study area, are represented by only one or two species. Of the 28 families present, 13 have only two species and 7 have only one species present (see Table 3).

TABLE 3.
Number of species in each of the 28 families present
at Tsehlanyane, Lesotho.

Compositae	36
Gramineae	23
Scrophulariaceae	10
Crassulaceae	8
Cyperaceae	6
Ericaceae	5
Caryophyllaceae	3
Gentianaceae	3
Adiantaceae	2
Juncaceae	2
Liliaceae	2
Iridaceae	2
Orchidaceae	2
Rosaceae	2
Leguminosae	2
Geraniaceae	2
Polygalaceae	2
Thymelaeaceae	2
Umbelliferae	2
Boraginaceae	2
Campanulaceae	2
Schizaeaceae	1
Eriocaulaceae	1
Velloziaceae	1
Phytolaccaceae	1
Oxalidaceae	1
Asclepiadaceae	1
Dipsacaceae	1



FIG. 3.
Moteng Pass area. X marks the treeline at 2 600 m.



FIG. 4.
Stunted *Buddleia* clump at 2 830 m.

The most striking feature of the vegetation in the study area is the almost complete lack of trees, shrubs and woody plants generally. The decrease in tree growth with increased altitude is a well-known phenomenon which has been recorded by many writers. The tree-line on the Natal escarpment of the Drakensberg is at approximately 1 830 m, while on the Lesotho side, in the Moteng Valley, it is at 2 600 m (see Fig. 3). The only rudiments of forest in the Tsehlanyane area are a few very stunted specimens of *Leucosidea sericea* and *Buddleia corrugata* growing in very rocky situations at 2 830 m. Tree-ring studies on these specimens indicated that their stems had grown to a diameter of 1.5 cm in 5 years in the case of *Buddleia* and in 19 years in the case of *Leucosidea*. In no case were these species taller than 1.3 m at this altitude (see Fig. 4).

This type of morphological adaptation is generally attributed to the effect of altitude on the ultra-violet fraction of sunlight, which reduces cell elongation through its inactivating influence on growth hormones. There is evidence that the local distribution of these species is limited to rocky situations because of the protection which such habitats afford against fire. It may further be assumed that the slow growth rate is due to low temperatures and not to moisture deficiency *per se*, although physiological drought must operate under the temperature



FIG. 5.
Danthonia, *Erica* and *Helichrysum* at 3 000 m

conditions prevailing. Thus also the xeromorphic structure of many of the dominant species such as *Danthonia*, *Helichrysum* and *Erica* at the highest altitudes (see Fig. 5).

As far as the dense cushion-form habit of certain of the grasses is concerned, the influence of a century's continuous summer grazing by domestic stock must be taken into account. Thus while highly palatable species such as *Harpechloa* and *Themeda* are dense mat-forming types at Tsehlanyane, less palatable species such as *Danthonia* and *Festuca* are generally more upright and tufted in form.

The communities of specific habitats at Tsehlanyane will be dealt with in a separate report.

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ONTKIEMING VAN DORINGBOOMSAAD

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UITTREKSEL

In 'n kort bespreking van die anatomie van die testa van Suid-Afrikaanse *Acacia*-sade word die saad van *A. grandicornuta* as voorbeeld gebruik. Ontkiemingsproewe is gedoen wat daarop dui dat die rafeool 'n rol speel by die opheffing van hardskalgheid by *Acacia*-saad.

ABSTRACT

GERMINATION OF *ACACIA* SEED

In a brief discussion of the anatomy of the seed coat of South African *Acacia* species, the seed of *A. grandicornuta* is used as an example. Germination tests indicate that the raphole might be responsible for overcoming the hardseededness in *Acacia* seed.

INLEIDING

Dit is 'n bekende feit dat sade van die meeste peulplante (Leguminosae) 'n stewige testa bevat wat in die droë toestand ondeurlaatbaar is vir water. Hierdie eienskap staan bekend as *hardskalgheid* en dit stel die saad in staat om besonder lank kiemkragtig te bly. Vir die betrokke plante is dié eienskap van hardskalgheid 'n belangrike ekologiese aanpassing (Williams & Elliot, 1960) deurdat alle sade nie gelyktydig ontkiem nie en sade van sekere soorte vir baie jare in die grond kan lê voordat hulle sal ontkiem.

Alhoewel daar by enkele peulplantsoorte wel remstowwe in die vars saad voorkom soos by sekere klawersoorte, ontkiem die saad van ander soorte binne enkele dae nadat dit in staat gestel is om water op te neem.

Daar bestaan reeds 'n uitgebreide literatuur oor hardskalgheid soos o.a. Burns, 1959; Davies, 1928; Esdorn, 1930; Quinlivan, 1966; Williams & Elliot, 1960. Metodes wat toegepas kan word om die hardskalgheid van saad op te hef byvoorbeeld deur die saad óf vir 'n bepaalde tyd te kook, te brand, vir 'n bepaalde tyd in gekonsentreerde swawelsuur te dompel, te skuur of aan te sny bestaan ook. Die meeste van bogenoemde metodes is tot 'n meerdere of mindere mate doeltreffend maar die vraag ontstaan egter, wat veroorsaak die ondeurdringbaarheid van die testa (saadhuid) vir water en hoe word die hardskalgheid in die natuur opgehef. Om antwoorde op sekere van die vrae te vind is daar tydens 'n ondersoek van die sade van Suid-Afrikaanse *Acacia*-soorte (Robbertse, 1973) ook aandag aan die hardskalgheid geskenk.

UITWENDIGE MORFOLOGIE

Die vorm van die saad van die inheemse doringbome varieer aansienlik by die verskillende soorte, en dit is in die meeste gevalle redelik maklik om sade te identifiseer. Die sade word egter almal gekenmerk deur 'n u-vormige of sirkelvormige pleurogram wat die areool omgrens (Fig. 1). Die mikropilum lê teenaan die hilum terwyl die rafeool in die vorm van 'n wigvormige vlek aan die teenoorgestelde kant van die hilum geleë is.

ANATOMIE VAN DIE TESTA

Die anatomie van die testa word volledig deur Robbertse (1973) bespreek maar gerieflikheidshalwe word 'n paar uitstaande kenmerke hier herhaal.

Soos in Fig. 3 aangetoon en dit ook die geval is by die meeste peulplantsade, bestaan die testa uit 'n buitenste epidermis wat opgebou is uit langgestrekte selle, 'n hipodermale laag osteosklereïede, 'n aantal lae mesofilselle en 'n binneste epidermis. Genoemde lae neem hul oorsprong uit die buitenste integument van die saadknop, terwyl daar aangrensend aan die binneste epidermis ook nog

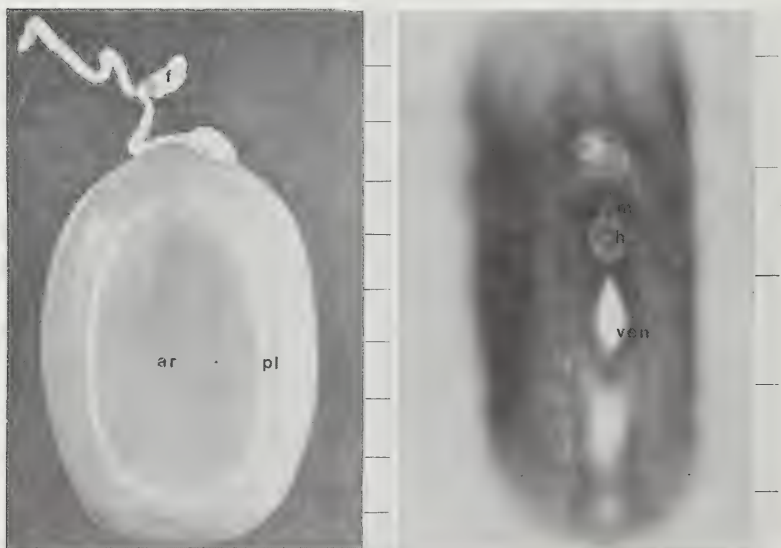


FIG. 1 & 2.

Saad van *Acacia karroo*. (Skaal in mm)

1. Syaansig.

2. Aansig vanaf die hilum.

ar = areool; f = funikulus; h = hilum; m = mikropilum; pl = pleurogram; ven = rafeool.

oorblyfsels van die binneste integument waargeneem mag word. Die posisie van die liglyn varieer by die verskillende spesies.

Die palissade epidermisselle het dik wande, sluit dig teen mekaar en is bedek met 'n dik kutikula om sodoende feitlik 'n waterdige laag om die saad te vorm. Die palissadeselle strek oor die hilum maar reg teenoor die rafeool is hulle heelwat korter as oor die res van die saad.

Die wit vlek by die rafeool word veroorsaak deur die met lug gevulde vaatweefsel van die rafe wat in dié gebied direk teenaan die verkorte palissade epidermisselle grens (Fig. 3). Tydens die studie is by enkele sade opgemerk dat die epidermis teenoor die rafeool barse vertoon of selfs afdop. Hierdie verskynsel kom veral voor by sade wat vir 'n tyd lank op die grond onder bome gelê het. Sade waarvan die epidermis teenoor die rafeool spontaan afdop is ook nie hardskelig nie en is in staat om water geredelik te imbibeer.

ONTKIEMINGSPROEWE

Eksperimente is uitgevoer met die saad van *A. karroo* en *A. robusta*. Van elke soort is 400 sade waarvan die epidermis teenoor die rafeool ongedeerd was,

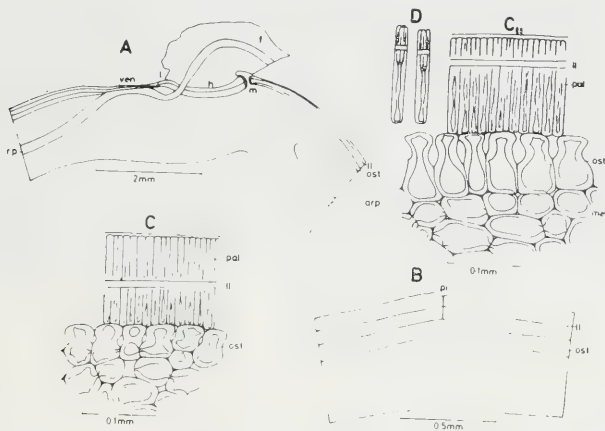


FIG. 3.

Die anatomie van die testa van *A. grandicornuta*.

- A. Gedeelte van 'n lengtesnee van die testa deur die rafeool en hilum.
 - B. Gedeelte van 'n dwarsdeursnee van die testa deur die pleurogram.
 - C. 'n Gedeelte van 'n dwarsdeursnee van die testa in die omgewing van die antirafe (CII) en in die omgewing van die antirafe (CII).
 - D. Gemassereerde epidermisselle.
- arp = antirafe; f = funikulus; h = hilum; ll = liglyn; m = mikropilum; mes = mesofil; ost = osteoskleriede; pal = palissade epidermisselle; rp = rafe; ven = rafeool.

uitgesoek; 200 sade per soort is as kontrole gebruik en by die orige 200 sade per soort is die epidermis oor die rafeool met behulp van 'n dissekteernaald geprik. Tydens dié proses spring 'n klein gedeelte van die epidermis geredelik af sodat die vaatweefsel van die rafee blootgelê word. Die sade van die proef en die kontrole is in herhalings van 25 sade op klam filtreerpapier in petribakkies geplaas en by 'n wisseltemperatuur van 25–30°C in die donker gelaat om te ontkiem.

In die geval van *A. karroo* was die ontkieming na 8 dae 99% in die geval van die behandelde saad en 3% in die geval van die kontrole. By *A. robusta* het 93% van die behandelde sade ontkiem terwyl 3% van die onbehandelde saad ontkiem het.

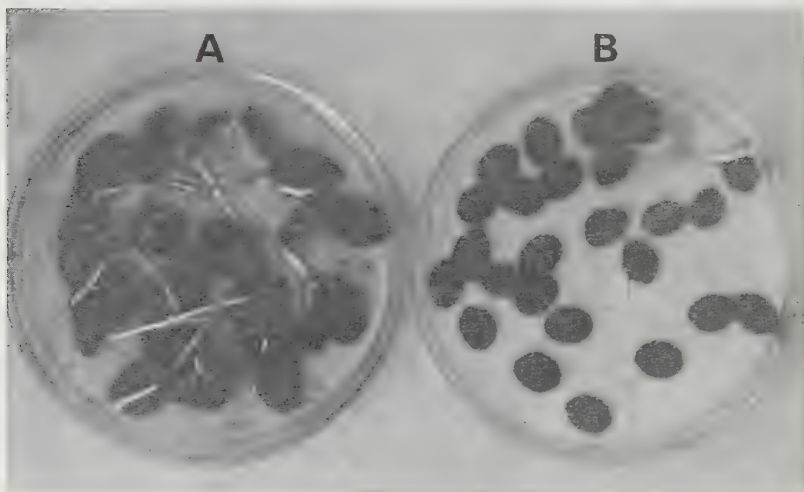


FIG. 4.

Ontkieming van die saad van *Acacia robusta*.

A. Saad waarvan die rafeool geprik is.

B. Kontrole.

'n Verdere eksperiment is uitgevoer deur 'n hoeveelheid saad van *A. robusta* wat gedurende Oktober 1972 op die grond onder die bome versamel is te gebruik. Saad waarvan die epidermis teenoor die rafeool spontaan afgedop het, is vir die proef gebruik terwyl die saad waarvan die epidermis teenoor die rafeool ongedoer was vir die kontrole gebruik is. Ses herhalings van 25 sade elk is in die geval van die proef én die kontrole in petribakkies op klam filtreerpapier geplaas en by die bogenoemde temperatuur gelaat om te ontkiem.

Na tien dae het 80% van die sade van die proef ontkiem, terwyl 16% van die saad van die kontrole ontkiem het.

BESPREKING

Dit wil dus voorkom of die rafeool tot 'n groot mate verantwoordelik is vir die opheffing van hardskalgigheid by *Acacia*-saad. Waar die palissade epidermisselle teenoor die rafeool om een of ander rede, soos onder andere moontlik deur die werking van mikro-organismes of herhaalde uitdroging en bevochtiging afdop, word die hardskalgigheid opgehef en kan die saad ontkiem. Sade waarvan die epidermis teenoor die rafeool nie afdop nie, bly hardskalgig totdat dit later om een of ander rede wel gebeur. Om hierdie rede kan 'n aantal sade dus onder gunstige toestande ontkiem terwyl ander ongedeerd in die grond sal bly lê en een of meer seisoene later eers sal ontkiem.

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STUDIES IN THE GENERA OF THE *DIOSMEAE* (RUTACEAE): 4.

ION WILLIAMS

(*Compton Herbarium, Kirstenbosch*)

ABSTRACT

A recent inspection of Type material in Europe has led to the publication of some changes in nomenclature. Two names are rejected. Three new combinations and one new name are proposed. Two new species from the Swellendam/Bredasdorp area are described.

UITTREKSEL

STUDIES IN DIE GENERA VAN DIE *DIOSMEAE* (RUTACEAE): 4

'n Ondersoek in die jongste verlede van die tipe materiaal in Europa het aanleiding gegee tot die publikasie van sekere veranderinge in die nomenklatuur. Twee name word verwys. Drie nuwe kombinasies en een nuwe naam word voorgestel. Twee nuwe soorte uit die Swellendam/Bredasdorp gebied word beskryf.

***Diosma rubra* L. Sp.pl. 1:198(1753) nom.rejic.**

Coleonema rubrum (L.) Druce in Bot. Soc. Exch. Club 1916. :616(1917) nom. rejic.

Diosma foliis setaceis acutis. L. Hort. Cliff. :72(1737).

Under *Diosma* in the *Hortus Cliffortianus* (1737), Linnaeus described three plants. The first of these was actually in cultivation in Clifford's garden and he described it in great detail. The second and third were based upon figures in existing literature published by the authors Plukenett, Commelin and Seba. It would appear that Linnaeus, at that time, had no access to the actual plants depicted and described by these authors. In the *Species Plantarum* ed. 1 (1753) he divided the third species of *Diosma* which he had described in the *Hortus Cliffortianus* into two parts, designating the first polynomial as a synonym of *Diosma rubra* and the second polynomial as a synonym of *Diosma ericoides*.

One of the polynomials cited by Linnaeus under *D. rubra* is *Spiraea odorata*, *floribus suaverubentibus*. Comm. Rar. : 2.t.2 (1706). This is a species of *Agathosma* (quite probably *A. serpyllacea* Licht.) and suggests that this is from where he obtained the epithet *rubra*.

It seems reasonable to suppose that Linnaeus was in possession of some dried plant material when he described his *Diosma rubra* as *Diosma folis linearibus*

acutis glabris subtus bifarian punctatis in 1753. This is supported by Sheet No. 270/4 in Linnaeus' herbarium marked *rubra* 3. in his own handwriting. Pinned to this is an exact duplicate, Sheet No. 270/5, without inscription. The following Sheet No. 270/6 bears a specimen collected by Sparrmann received by Linnaeus a long time after 1753 and the following three sheets, all without inscriptions, may have come from the Tulbagh collection or from Burman and so were also received after 1753. Thus the only sheet which has any bearing on typification of *D. rubra* is Sheet No. 270/4. Mounted on this sheet are two specimens, the one on the left hand side being a twig of *Coleonema album* and that on the right hand side, partly superimposed, being a twig of *Diosma hirsuta*. Both of these specimens are exactly as described by Linnaeus' diagnostic phrase and so we must conclude that Linnaeus regarded these plants as being conspecific. The name *Diosma rubra* is therefore rejected under Article 70 of the Code, as it is based upon a type consisting of two entirely discordant elements neither of which can be selected as a lectotype. For the same reason the combination *Coleonema rubrum* (L.) Druce is also rejected.

It is interesting to note that the cultivated specimen of *D. hirsuta* from Clifford's garden is extremely pubescent whereas specimens of *D. hirsuta*, such as *D. rubra* ex parte in Linnaeus' herbarium, from the wild are all very much more glabrous although the degree of pubescence may vary considerably. This evidently misled Linnaeus into thinking that they were different plants.

In England *Coleonema album*, the other element in *Diosma rubra* L. in Linnaeus' herbarium, was in cultivation and was commonly known as *D. ericoides*. Salisbury (1796) proposed substituting *D. juniperifolia* for *D. rubra* L. stating: "Commonly known in gardens as *D. ericoides*. A light green herb, with white flowers, wherefore the Linnaean naming is the worst".

***Diosma oppositifolia* L. Sp.Pl. 1: 198 (1753).**

Iconotype: *Spiraea Africana foliis cruciatim positis*. Fig. 1. Comm. Hort. Med. Amst. (1706).

D. succulenta Berg. Descr. Plant. Cap.: 63 (1767) excl. syn. Pluk. Type: in Bergius' Herbarium (S-BT).

D. scabra Lam. Encycl. Meth. Bot. 2: 283 (1786). Type: Without locality, collector or number; labeled *Diosma scabra* Lam. Dict. (P-LA). Lamarck states; "This plant grows at the Cape of Good Hope and it was received from Mr. Sonnerat together with most of the other specimens mentioned below".

D. decussata Lam. Encycl. Meth. Bot. 2: 284 (1786). Type: Without locality, collector or number; right hand specimen on sheet in Herb. Lamarck (P-LA).

D. rigidulum (or *rigidum*) Willd. Enum. Plant. Supp.: 12 (1813). nom. nud.

D. succulenta Berg. var. *bergiana* Sonder in Flor. Cap. 1: 373 (1860).

PRE-LINNAEAN CITATION: *Spiraea Africana foliis cruciatim positis*. Comm. Hort. Med. Amst.: 1 (1706). 2. *Diosma foliis subulatis acutis* L. Hort. Cliff. :71 (1737) ex parte.

ICONES. *Spiraea* . . . Comm. Hort. Med. Amst. t.1. (1706); *D. succulenta* Wendl. Coll. Plant. t.1. (1805).

A recent examination of both Clifford's herbarium and Linnaeus' herbarium have shown that, up to the time in 1753, when he proposed the name *Diosma oppositifolia*, Linnaeus had never seen a specimen of the plant currently known as *D. succulenta* Berg. This is quite clearly shewn in his own herbarium where he tried to fit the name *oppositifolia* to the plant on Sheet No. 10 and then crossed it out and put its name on Sheet No. 1 which was also in error as the plant on that Sheet is *D. hirsuta* L. Of the two Sheets which actually bear twigs of *D. succulenta*, No. 2 bears the name *oppositifolia* in his son's handwriting (fide Jackson) and No. 21, without any name, was received from Sparrmann much later than 1753.

If we consider the *Hortus Cliffortianus*, the only *Diosma* described at length was one that was actually growing at that time in Clifford's garden. The other two descriptions were based upon illustrations that had appeared in literature before 1737. Of these there is no relevant specimen to be found in Clifford's herbarium.

One must conclude, therefore, that the name *D. oppositifolia* L. is based upon literature and consider the merits of the polynomials cited by Linnaeus.

At first it is significant that Linnaeus amplified his name phrase from that in the *Hortus Cliffortianus* by adding the word *oppositis*. His description, in Sp. Pl. 1, reads *oppositifolia*. 1. *Diowma foliis subulatis acutis oppositis*. This agrees exactly with the illustration *Spiraea Africana foliis cruciatim positis*: Fig. 1 in Commelin (1706) which is the first polynomial cited by Linnaeus. Furthermore there can be no doubt whatever that the plant described and depicted by Commelin, and formerly cultivated in Amsterdam, was what is currently known as *D. succulenta* Berg.

The second polynomial cited by Linnaeus *Hypericum africanum vulgare* of Seba is *D. hirsuta* L. This is a plant in which the leaves are alternate, never opposite. One can therefore say that the description of *D. oppositifolia* applies to the first polynomial which is Commelin's drawing and not to the second polynomial which is Seba's drawing. Under articles 53 and 70 of the Code, Commelin's plate is therefore selected as the *Icono-lectotype* of *D. oppositifolia* L. and the name *D. succulenta* Berg. is reduced to synonymy.

In the *Flora of the Cape Peninsula* (1950) Miss E. E. Esterhuysen upheld the name *Diosma oppositifolia* L. and placed *D. succulenta* Berg. in synonymy.

***Diosma apetala* (Dümmer) Williams, comb. nov.**

Acmadenia apetala Dümmer in *Fedde Repert.* **11**: 121 (1912). Type: South Africa, on moist and stony mountain places near Vrolykheid, 1 200–1 500 m, on the Great Zwartbergen (August), *Drège* 2250 (K, holo.).

Diosma bolusii Glover in *Ann. Bol. Herb.* **1.3**: 26 (1915). Type: Cape Province: South Western Region; on rocky slopes of the Zwartberg Mountains in the Zwartberg Pass, Prince Albert Div., *H. Bolus* 11460 (BOL, holo.).

ICON: Glover loc. cit. **1.3.t.15.f.c** (1915).

A recent inspection of Dümmer's type at Kew has shown that it exactly matches *Diosma bolusii* Glover. This is a fairly well-known species of which several gatherings have been made. A unique character of this plant is that the petals never unfold as is in a normal flower, but remain coherent forming a small cap which falls away when the flower opens. The calyx lobes are by then widely spread, pale in colour and give a 5-petaled appearance to the minute flower. In Dümmer's specimen the petals had already delapsed and he was therefore misled into thinking this flower to be apetalous.

With regard to the generic status of this plant, it would appear that the presence of staminodes led Dümmer to place it in *Acmadenia*.

In specimens of *Diosma* so far examined 9 different species were found to have no trace whatever of any staminodes and 5 different species were found to

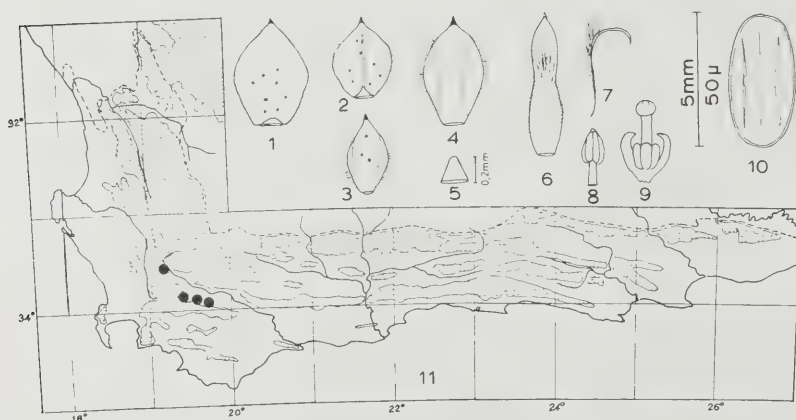


FIG. 1.

Euchaetis pungens: 1, leaf. 2, bract. 3, bracteole. 4, calyx lobe. 5, staminode. 6, petal. 7, side view of petal. 8, anther. 9, gynoecium. 10, pollen. 11, distribution.

have staminodes that were vestigial, being represented by a minute sessile hemispherical gland ranging in size from 0.10–0.25 mm in diameter. The species here under discussion was found to be unusual in having staminodes that were minute glands, spherical in shape about 0.15 mm in diameter. This difference is so slight however as scarcely to warrant placing this species in another genus. The widely open flower with its cup shaped 5-lobed disc has very much the appearance of *Diosma*. It is not in the least like *Acmadenia* in which the reproductive parts are more or less concealed by the claws of the petals. This plant is also very similar in general appearance and habit to several other species of *Diosma* notably *D. guthriei*, *D. ramosissima* and *D. passerionoides*.

Collections from widely spread areas in the Little Karoo from the Roodeberg to the Kougaberg, of a species resembling *D. ramosissima* also closely resemble *D. bolusii* in having the same spherical staminodes but these plants all retain their petals when flowering.

There seems to be no doubt that *Acmadenia apetalata* Dümmer should be placed in *Diosma* and, as Dümmer's epithet has priority of publication, it is found necessary to make the new combination *Diosma apetalata* (Dümmer) Williams.

***Euchaetis pungens* (Bartl. & Wendl.) Williams, comb. nov.**

Acmadenia pungens Bartl. & Wendl. *Diosmeae* in Beitr. Bot. 1:64 (1824). Type: L. hand specimen on Sheet No. 4784 in herb Willdenow, received from Jacquin (B, holo. W, iso). Note: at Vienna there are four sheets of isotypes of this species collected for Jacquin by Scholl at the Cape of Good Hope.

SPECIMENS EXAMINED

CAPE—3319 (Worcester): (-CA) In montibus pone Bainskloof, 2 500 ft. 5/2/1897 *Schlechter* 10260 (BM, BOL, PRE); Darling Bridge, 14/9/1941 *Esterhuysen* 6094 (BOL); Romans River, 17/11/1941 *Compton* 12508 (NBG); (-CB) North end Dutoitskloof in sand amongst rocks, 25 2/1952 *Esterhuysen* 20114 (BOL); (-CD) In arenosis prope Brandvlei, 1 000 ft. 8/1/1896 *Schlechter* 9922 (BM, BOL, K, P, PRE, BR, W); Slopes of Brandvleiberg, - 6/1940 *Esterhuysen* 1924 (BOL, K, NBG, SAM); Brandvleikop, 2/6/1940 *Bond* 368 (NBG); Hill near Moordkuil, Bosjesveld, 1 000 ft. 24/10/1828 *Drège* 7152 (P); Moordkuil, S. end of Quaggaskloof Dam, 700 ft. 11/5/1973 *Williams* 1797 (NBG). Without precise locality: *Scholl s.n.* (B-W 4784 L.H. spec., MEL, W); *Thunberg s.n.* (UPS-TH 5716 as to a and b only); Hottentots Holland (loc. doubtful), *Günzlin s.n.* (MEL, W 311).

The collection of fresh material at Moordkuil in the Worcester Division during 1973 made possible a detailed examination of this plant and revealed

that it could be more satisfactorily placed in *Euchaetis* than in *Acmadenia*. Characters pointing to this are: (1) the strongly bearded petals which completely hide the anthers and stigma; (2) the very short filaments and style which keep the anthers and stigma within the surrounding bearded petals; (3) the staminodes which are either absent or at most 0.2 mm long; (4) the anthers which possess a very small apical gland.

***Euchaetis diosmoides* (Schltr.) Williams, comb. nov.**

Acmadenia diosmoides Schltr. in *Bot. Jb.* **24**: 439 (1898). Type: Western Cape: On sandy places near Elim, 100–150 m above sea level, flowering on 20th April 1896. *Schlechter 7654* (BOL, lecto.; BM, K, P, PRE, W).

SPECIMENS EXAMINED

CAPE—3419. (Caledon): (-DA) 2,5 km S. of Viljoenshof, Bredasdorp Div., 300 ft, 13/11/1971 *Williams 1593* (NBG), 30/1/1973 *Williams 1755* (NBG); (-DB) Elim, 400 ft, 20/4/1896 *Schlechter 7654* (BM, BOL, K, P, PRE, W); In hills near Elim, 300 ft, -'12/1896 *H. Bolus 8531* (K); 2,4 km S. of Elim, Bredasdorp Div., 250 ft, 13/11/1971 *Williams 1592* (NBG).

The gathering of fresh material in 1971 and again in 1973 has provided the opportunity for making a close inspection of this plant. The petal, with a markedly transverse beard, immediately places this species into the genus *Euchaetis*. Other characters which support this are the presence of vestigial staminodes, the capitate stigma and the five-chambered ovary. It is hard to

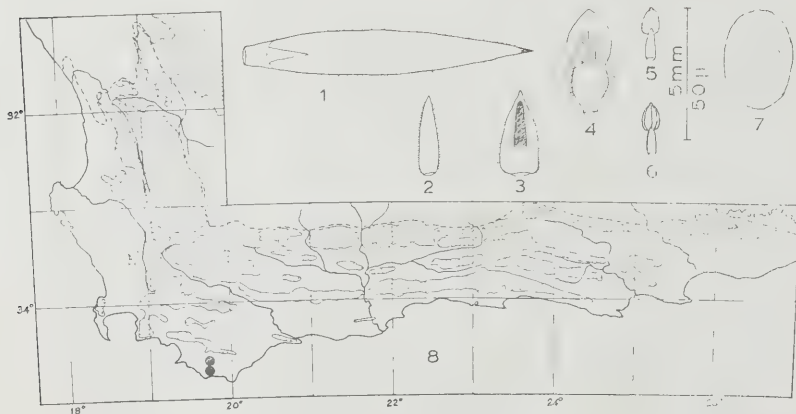


FIG. 2.

Euchaetis diosmoides: 1, leaf. 2, bracteole. 3, calyx lobe. 4, petal. 5, anther—dorsal view. 6, anther front view. 7, pollen. 8, distribution.

visualise what persuaded Schlechter to place this plant with *Acmadenia*. He compares it with two other species; *Acmadenia rosmarinifolia* Bartl., which has been found to be more satisfactorily placed in *Agathosma*, and *Acmadenia laevigata* Bartl. & Wendl., (= *Acmadenia assimilis* Sond.)

Euchaetis diosmoides is most closely related to *Euchaetis schlechteri* Schinz and it is interesting to note that both these plants are found growing in brownish loamy soil which is rather unusual in this genus.

There is a certain amount of confusion in the typification of this species that needs to be clarified. Schlechter published the two names *Euchaetis longibracteata* and *Acmadenia diosmoides* at the same time in Engler's *Botanische Jahrbuch* (1898). His descriptions exactly match his material, with labels correctly named in his own handwriting, duplicates of which are to be found in many herbaria. However in the published work the specimens cited relative to each species have been transposed. This must be regarded as a typographic error and these species are then correctly typified as follows:

Euchaetis longibracteata Schltr. Type: Western Cape: on stony hills near Elim, 80 m above sea level, flowering in April 1896. *Schlechter* 7627 (BOL, lecto.; BM, K, P, PRE, W).

Euchaetis diosmoides (Schltr.) Williams. Type: Western Cape: On sandy places near Elim, 100–150 m above sea level, flowering on 20th April 1896. *Schlechter* 7654 (BOL, lecto.; BM, K, P, PRE, W).

Together with his 7627 from near Elim Schlechter also cites his 7586 "from a few places in the mountains at Houw Hoek, at 600 m above sea level". Unfortunately it has been impossible to trace any material relating to this gathering. The locality is a long way from Elim and one would not expect to find this plant at Houw Hoek.

Acmadenia sheilae Williams, nom. nov.

Acmadenia gracilis Compton in *J. Bot., Lond.* **70**: (1932) nom. illegit. Type: Cape Province; Ladismith Division, Roodeberg, near Van Wyk's Dam, 4 000 ft., 1/11/1931, *Compton* 3859 (BOL, holo.; K. iso.); non *Acmadenia gracilis* Dümmer in *Fedde Repert.* **11**: 163 (1912).

SPECIMENS EXAMINED

CAPE—3320 (Montagu): (-DB) Touwsberg, 3 000 ft., 1/6/1956 *Esterhuysen* 25907 (BOL), 19/8/1956 *Wurts* 1455 (NBG); 3321 (Ladismith): (-AD) Seven Weeks Poort, -9/1928 *Pocock* 1005 (BOL); 12/10/1955 *Esterhuysen* 24758 (BOL), 30/3/1959 *Esterhuysen* 28291 (BOL), 7/5/1963 *Wurts* 4741 (K, PRE, STE), 10/7/1903 *Marloth* 3222 (PRE), -9/1912 *Thomas* 1476 (K, PRE), Swartberg beyond Seven Weeks Poort, -12/1930 *Muir* 4608 (K, PRE); Bushbuckkloof Pass, 3 500 ft., 14/11/1938 *Hall* 55 (BOL); (-CB) Zwart Mt. S. of Amalien-

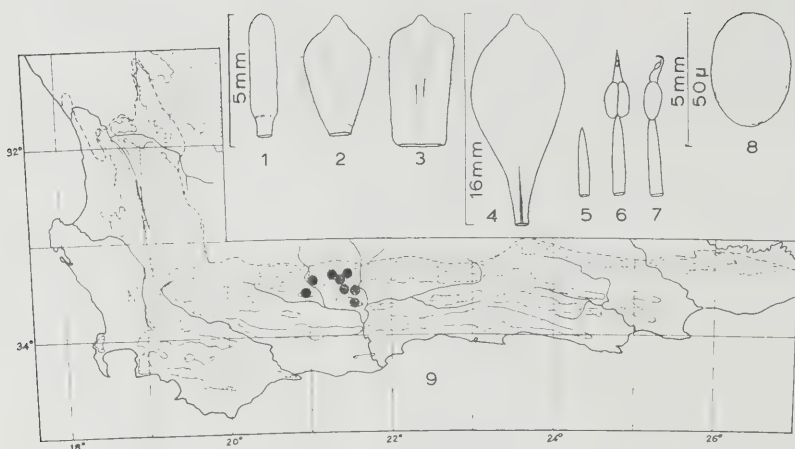


FIG. 3.

Acmadenia sheilae: 1, leaf. 2, bract. 3, calyx lobe. 4, petal. 5, staminode. 6, anther—front view. 7, anther—side view. 8, pollen. 9, distribution.

stein, 29/11/1926 *Liebenberg* 708 (PRE): (-DA) Gamka Pass near Calitzdorp, 24/5/1950 *Esterhuysen* 17126 (BOL, K, NBG): (-BC) Paardeberg, Huis River Pass, 23/5/1950 *Esterhuysen* 17114 (BOL): (-AC) Buffelsrivier Poort, W. Klein Swartberg, 2 500–3 200 ft, 26/4/1973 *Williams* 1790 (NBG): (-DA) Roodeberg (Rooiberg), 4 000 ft., 1/11/1931 *Compton* 3859 (BOL, holo.; K, iso.), -/3/1940 *Lewis* 1755 (SAM), 18/8/1954 *Wurts* 1299 (NBG); Roodeberg, 8/8/1949 *Barker* 5490 (BOL, NBG), 24/5/1950 *Esterhuysen* 17176 (BOL), 24/3/1940 *Kies* 223 (NBG), 8/8/1949 *Barker* 5503 (NBG); Roodeberg Pass, 2 000–2 600 ft, 4/7/1948 *Acocks* 14618 (K, PRE), 15/3/1959 *Acocks* 20359 (K, NBG), 19/7/1954 *Rycroft* 1645 (NBG), 17/9/1967 *Rourke* 857 (NBG), 30/10/1971 *Williams* 1573 (NBG), 23/8/1969 *Rycroft* 3034 (NBG), 19/7/1954 *Lewis* 4725 (SAM), 6/10/1971 *Oliver* 3677 (STE).

A recent inspection of Dümmer's type material at Kew has shown that *Acmadenia gracilis* Dümmer should really fall within the concept of *Acmadenia trigona* (Ecklon & Zeyher) Druce. This species shows a certain amount of variation. Plants with the smallest leaves, such as those shown by *A. gracilis* Dümmer, are found at the southern end of its range of distribution near the Robinson Pass. At the western end, near Garcias Pass, plants are found with much larger leaves. The specimens of Ecklon & Zeyher are somewhat intermediate in size and were found more towards the centre of this area of distribution. These leaves are characteristically somewhat trigonal with a very acute

apex. On the other hand the leaves of *A. gracilis* Compton are terete, obtuse and very much smaller. It is obviously a very different plant and is found on the Roodeberg and Swartberg mountains.

Acmadenia gracilis Compton is a homonym of *A. gracilis* Dümmer and must be rejected. As a new name the epithet *sheilae* has been chosen in honour of my wife whose invaluable assistance in my work merits a lot more than just this simple tribute.

***Acmadenia laxa* Williams, sp. nov.**, propria propter folia obtusa opposita, flores singuli foliis bractisimilis binatim basim cingens, antherae apice minute glanduliferae.

Type: CAPE—3420 (Bredasdorp): (—AB) Bontebok National Park, Swellendam, 110 m, 27/7/1973 *Williams 1828* (NBG, holotype; M, MO, PRE, S, STE, isotypes).

Acmadenia obtusata sensu Bartl. & Wendl. *Diosm. in Beitr. Bot.* 1: 63 (1824).

Frutex c. 20 cm, laxis, ad basim ramificans. *Rami* brevi, graciles, oppositi, puberuli. *Folia* 4–8 mm longa, 1–2 mm lata, opposita, quadrifaria, adpressa, erecta, lanceolata, obtusa, sessila, ciliata, complicata vel canaliculata, sparse pubescentia, obscure punctulata. *Flores* 15 mm diam., singuli, terminali, rosei, foliis bracti similis binatim basim cingens. *Bracteae* bini, 3.5 mm longae, 2.5 mm latae, adpressae, orbiculares. *Bracteolae* bini, 4 mm longae, 3 mm latae, orbicu-

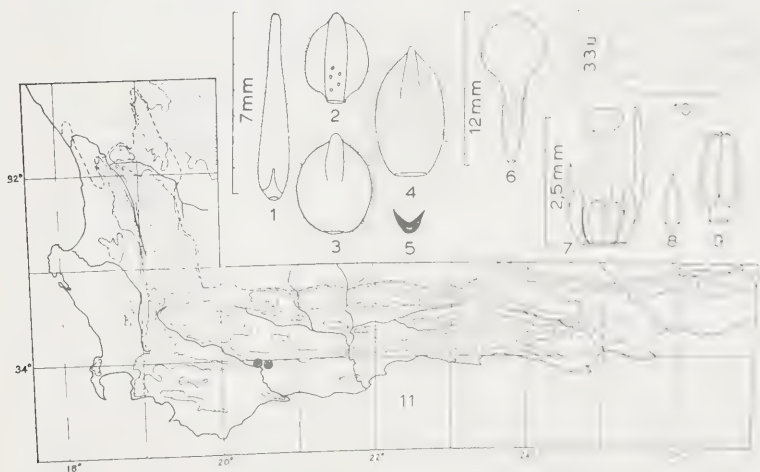


FIG. 4.

Acmadenia laxa: 1, leaf. 2, bract. 3, bracteole. 4, calyx lobe. 5, cross section of leaf. 6, petal. 7, gynoecium. 8, staminode. 9, anther. 10, pollen. 11, distribution.

lares, apiculatae, ciliatae. *Sepala* quinque, 5 mm longa, 2,8 mm lata, elliptica, apiculata, pubescentia, ciliata, rosea. *Petala* quinque, 12 mm longa, 5,2 mm lata, rosea, ciliolata, obtuse apiculata, unguibus angustis pubescentibus. *Staminodia* quinque, 1 mm longa, apice minute glandulifera. *Fila* quinque, glabra, post anthesin 2 mm longa. *Antherae* quinque, ante anthesin 1,5 mm longae, 0,8 mm latae, minute glanduliferae. *Pollen* 60μ longum, 33μ diam., oblongum. *Stigma* 0,8 mm diam., capitatum. *Stylus* glaber, 1,7 mm longus. *Ovarium* quinque—carpellatum, 0,8 mm diam. *Fructus* quinque-carpellatus, 7 mm longus, 5 mm diam., glaber, cornibus brevibus 1 mm longis. *Semen* 3,5 mm longum, 1,5 mm latum, piceum, nitens.

This species, which occurs in the vicinity of the town of Swellendam, has been known for many years having been collected by Roxburgh, Burchell, Zeyher, Drège and many others. When Bartling and Wendland published the combination *Acmadenia obtusata* (Thunb.) B. & W. in 1824 they had apparently never examined the type of *Diosma obtusata* Thunb. in Thunberg's herbarium but based their accompanying description upon a plant in Willdenow's herbarium which Willdenow had erroneously labeled as *Diosma obtusata*. Consequently, specimens of *Acmadenia obtusata* sensu B. & W. are not conspecific with *Acmadenia obtusata* (Thunb.) B. & W. but are of another taxon which is here described *de novo*.

Shrubs about 20 cm tall, lax, branching from near the base with a tough rootstock. *Branches* short, slender, frequently opposite, pubescent with matted erect hairs, well clothed with leaves at first. *Leaves* of very young plants spreading-erect, soon becoming adpressed-erect, 4–8 mm long, 1–2 mm broad, opposite, 4-ranked, lanceolate, obtuse, sessile, ciliate, complicate or canaliculate, sparsely pubescent, obscurely gland-dotted. *Flowers* 15 mm diam., solitary, terminal, pink. Towards the flowers the pairs of leaves gradually become bract-like. *Bracts* two, 3,5 mm long, 2,5 mm broad, adpressed, orbicular with a blunt point at the apex, very sparsely pubescent, margins broad translucent and ciliate, midrib prominent bearing small gland-dots. *Bracteoles* two, 4 mm long, 3 mm broad, orbicular, apiculate, sparsely pubescent above, margins broad translucent and ciliate, midrib prominent and green towards the apex. *Calyx lobes* five, 5 mm long, 2,8 mm broad, elliptic, apiculate, somewhat pubescent, strongly ciliate, margins broad translucent and pinkish. *Petals* five, 12 mm long overall with the limb 7,5 mm long, 5,2 mm broad, sub-orbicular, apex with an obtuse point, narrowed to the base, pink, ciliolate, sparsely and minutely pubescent on the upper side, minutely pubescent with a few gland dots on the underside; the claw 4,5 mm long, 1,5 mm broad, pubescent on both surfaces and ciliate at the throat of the flower, narrowed and glabrous below. *Staminodes* five, 1 mm long, glabrous, fairly stout with a pointed gland 0,2 mm long at the apex. *Filaments* five, becoming 2 mm long, acicular, erect, glabrous. *Anthers*

five, before anthesis 1,5 mm long, 0,8 mm broad, wine coloured with a minute apical gland. Pollen 60 μ long, 33 μ diam., oblong. Disc exceeds the ovary slightly, surrounds the stigma at first, dark green, exudes nectar. Stigma 0,8 diam., capitate, depressed globose, green, becoming sticky. Style becoming 1,7 mm long, terete, glabrous, erect. Ovary 5-carpellate, 0,8 mm diam., sparsely pubescent at the sides. Fruit 5-carpellate, 7 mm long, 5 mm diam., glabrous; horns short, about 1 mm long. Seed 3,5 mm long, 1,5 mm broad, black, shining.

SPECIMENS EXAMINED

CAPE—3420 (Bredasdorp): (-AB) Hills near Swellendam, 500–1 000 ft., -/7/1887 *F. Bolus* 618 (BM, BOL, K, P, SAM, W), 7/9/1924 *Compton* 3448 (BOL), 5/9/1955 *Esterhuysen* 24622 (BOL), 22 1 1815 *Burchell* 7438 (K), 11/10/1900 *Pappe s.n.* (MEL), 22/5/1952 *Wurts* 126 (NBG), 2/7/1952 *Wurts* 211 (NBG), 3/9/1964 *Rothman s.n.* (NBG), 27/7/1973 *Williams* 1827 (NBG), -/7/1900 *Fry s.n.* (*Galpin* 4989, PRE), -/10/1918 *Marloth* 8035 (PRE), 27/9/1926 *Marloth* 12592 (PRE, STE), -/10/1869 *Kennedy s.n.* (*Macowan* 1704, SAM), -/10/- *Lamb* 2226 (SAM); Bontebok Park, 350–500 ft., 23 8 1965 *Grobler* 462 (K, PRE, STE), 27/7/1973 *Williams* 1828 (NBG, holotype; M, MO, PRE, S, STE, isotypes), 20/6/1962 *Acocks* 22226 (PRE), -/9/1962 *Liebenberg* 6590 (PRE, STE): (-BA). On both sides of the Buffeljagsrivier from Swellendam to Rietkuil, -/9/- *Zeyher* 2160 (GOET, K, MEL, P, PRE, SAM, W); Sparrbosch 25/7/1831 *Drège* 7114 (BM, K, P, PRE, W). Without precise locality, *Roxburgh s.n.* (BM). Without collectors name or locality, (B-W4785/2, lecto.), (LD 106).

DISTRIBUTION AND BIOLOGY

Acmadenia laxa occurs in a very small area, probably not more than fifteen kilometres long by five kilometres broad, on hills in the vicinity of Swellendam and Buffeljagsrivier. Plants are found growing at altitudes varying from 100–300 m (350–1 000 feet) on dry, stony, gravelly or shaly ground probably derived from the lower series of the cretaceous system which occurs as a small outlier in this area. Flowering appears to take place from June until October with seeds probably ripening until January. The claws of the petals are pubescent and bulged inwards at the throat of the flower with the result that the reproductive parts, including the disc which secretes nectar, are completely concealed within a small chamber. The petals are widely spread and provide a conspicuous display no doubt in order to attract insects to the flower. The anthers ripen and are stripped of their pollen before the style elongates and raises the stigma up to the vicinity of the empty anthers. The pollen is sticky and does not fall down upon the stigma when the anther ripens. This plant would therefore appear to be pollinated by insects but one wonders whether, in the absence of insects, it could not become self-pollinating. The slippery ripe seeds are ejected by a cata-

pult mechanism which ensures a certain degree of dispersal. The plants appear to coppice from the root which means they may survive light veld fires or grazing by animals.

This species possesses the following generic characters. (1) The *flowers* are solitary. (2) The *petals* are pubescent and bulged inwards at the throat. (3) *Staminodes* are present, being 1 mm long. (4) *Anthers* bear a minute apical gland which is perhaps not typical. (5) The *disc* is well developed and exceeds the ovary. (6) The *Stigma* is capitate. (7) The *style* is short and erect. (8) The *filaments* and *style* are glabrous. (9) The *ovary* is 5-carpellate. (10) The *fruit* is short-horned.

With the exception that the anther bears only a minute apical gland instead of something rather larger, this plant appears to belong in the genus *Acmadenia* Bartl. & Wendl.

Acmadenia laxa is recognised as distinct on account of its having leaves that are opposite and obtuse, flowers solitary, with numerous pairs of bract-like leaves at the base of each, and anthers bearing a minute apical gland. It differs from *Acmadenia niveni*, *Acmadenia macropetala* and *Acmadenia sheilae* which have anthers with large pointed apical glands.

The epithet *laxa* is an allusion to the slender branchlets of this plant which are rather more lax in habit than those of *A. obtusata* (Thunb.) B. & W.

Euchaetis scabricosta Williams, sp. nov., propria propter folia opposita, ciliata, breviter petiolata, costis scabris monoseriati-punctatis, carpella cornibus erectis longis.

Frutex c. 30 cm, multicaulis. *Rami* recti, graciles, erecti vel laxi, tomentosi. *Folia* 5–10 mm longa, 2–2,5 mm lata, glabra, lanceolata, acuta, minute callosa, complicata, opposita, decussata, imbricata, erecta, marginibus hyalinibus, tenuibus, minute punctatis, ciliatis, ad basim breviter petiolata, costis scabris monoseriati-punctatis. *Bractea* una, folium simulans. *Bracteolae* duae, c. 4 mm longae, 1,5 mm latae, glabrae, ciliatae. *Sepla* quinque, 4 mm longa, 2,7 mm lata, apiculata, sub-orbiculata, ciliata. *Petala* quinque, 5,5 mm longa, 2,5 mm lata, alba vel sub-rosea, orbiculata, transverse barbata, unguibus ciliatis. *Staminoda* quinque, vestigialia. *Fila* quinque, glabra, post anthesin 2 mm longa. *Antherae* quinque, ante anthesin 1,3 mm longae, 0,8 mm latae, oblongae, roseae, apicibus minute glandulosis. *Pollen* 55 μ longum, 35 μ diam., oblongum. *Discus* ovarium excedens, viridus. *Stigma* c. 0,6 mm diam., capitatum. *Stylus* glaber, 1,3 mm longus. *Ovarium* 5-carpellatum, 0,9 mm diam., glabrum vel apicibus setulosus. *Fructus* 5-carpellatus, 8 mm longus, 5 mm diam., glaber, cornibus 2,5 mm longis, erectis. *Semen* 3,8–5 mm longum, 1,8 mm latum, piceum, nitens.

Type: CAPE—3420 (Bredasdorp): (–BC) Potberg, sandy flats on south side of mountain, 3 km from Potberg farm, Bredasdorp Division, 19/9/1972 Williams 1689 (NGB, holotype).

A specimen of this plant was collected by Harry Bolus on hills near Elim in 1894 and, together with later similar collections, was placed under *Acmadenia*

assimilis in the Bolus Herbarium. *Acmadenia assimilis* Sonder and *Euchaetis laevigata* Turcz are conspecific but refer to a species which may readily be recognised as differing from *Euchaetis scabriocosta* as it possesses very small orbicular leaves.

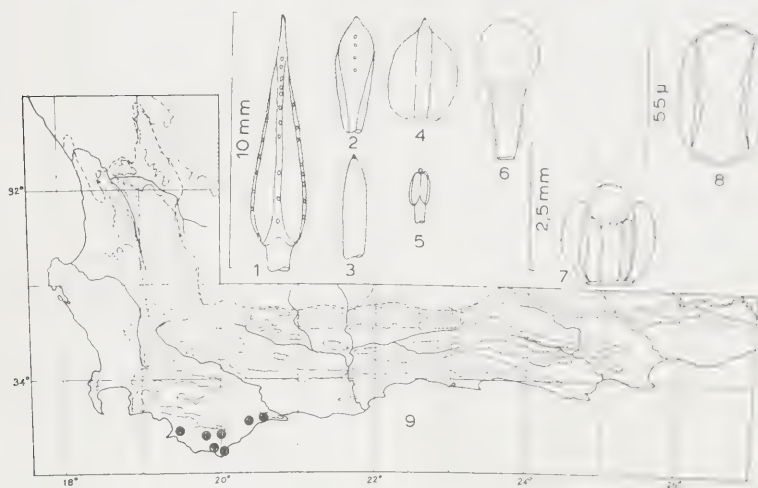


FIG. 5.

Euchaetis scabriocosta: 1, leaf. 2, bract. 3, bracteole. 4, calyx lobe. 5, anther. 6, petal. 7, gynoecium. 8, pollen. 9, distribution.

Shrubs about 30 cm tall with several slender stems occasionally arising from a fairly stout rootstock. *Branches* slender, straight, erect or lax, clothed with a short erect pubescence, hidden beneath the leaves. *Leaves* 5–10 mm long, 2–2.5 mm broad, glabrous, opposite, decussate, imbricate, erect, lanceolate, acute, with a small callus at the apex, margins ciliate, narrowly translucent and dotted with small glands, narrowed at the base to a short petiole, dorsal ridge prominent and glandular-serrate, adaxial surface deeply hollowed, complicate when dried. *Bract* one, leaflike, 4.6 mm long, 1.5–1.9 mm broad, glabrous, lanceolate, ciliate. *Bracteoles* two, about 4 mm long, 1.5 mm broad, glabrous, ciliate, somewhat asymmetrical with broad translucent margins. *Inflorescence* terminal in groups of up to 6 flowers which themselves may be aggregated into quite large clusters, each flower 6 mm diam., white or pink with the throat closed by a fringe of hairs. *Calyx lobes* five, 4 mm long, 2.7 mm broad, apiculate, sub-orbicular, margins ciliate and broadly translucent, midrib with or without a few hairs near the apex. *Petals* five, 5.5 mm long including the claw; *limb* 2.5 mm diam.,

orbicular; *claw* 3 mm long, 1,3 mm broad, transversely bearded above, laterally ciliate, narrowing to the base. *Staminodes* five, vestigial, a minute gland about 0,05 diam. *Filaments* five, becoming 2 mm long, glabrous, subulate. *Anthers* five, before anthesis 1,3 mm long, 0,8 mm broad, oblong, bilobed, purplish-red with a minute apical gland. *Pollen* ellipsoid, 55μ long, 35μ broad. *Disc* extends well over the ovary, green, fleshy, exudes nectar. *Stigma* about 0,6 mm diam., capitate, globose, green, viscid. *Style* becoming about 1,3 mm long, glabrous, ever-erect. *Ovary* 5-carpellate, 0,9 mm diam., glabrous or with a few hairs at the apices of the carpels. *Fruit* 5-carpellate, 8 mm long, 5 mm diam., glabrous, gland-dotted on both margins in the lower half; *horns* 2,5 mm long, erect, apices somewhat bifid clasping a minute gland. *Fruit* 3,8–5 mm long including the white aril, without the aril 2,8–4,3 mm long, 1,8 mm diam., black, shining.

SPECIMENS EXAMINED

CAPE—3419 (Caledon): (-CB) On road between Gansbaai and Napier ca. 6 m, 22/9/1938 *Gillet* 4333 (BOL); (-DB) On hills near Elim 300 ft., -/10/1894 *H. Bolus* s.n. (BOL 13713); Near Elim, 10,8.1949 *Steyn* 355 (NBG); Bredasdorp/Elim, 8.10.1950 *Compton* 22129 (NBG); Springfontein near Salt Pan, 50 ft., 1/8/1973 *Williams* 1831 (NBG). CAPE—3420 (Bredasdorp): (-CA) On hills near Bredasdorp, -/7/1895 *H. Bolus* s.n. (BOL); S. slopes of Bredasdorp Mt., 15/10/1951 *Esterhuysen* 19151 (BOL); (-CC) Northumberland Point, 150 ft., 13/10/1969 *Acocks* 24261 (K, PRE); Struisbaai, 50 ft., 21/6.1972 *Williams* 1660 (NBG); (-BC) Potberg, lower S. slopes, 18,9.1954 *Esterhuysen* 23207 (BOL, NBG); Potberg, stony sandy flats, 19,9/1954 *Esterhuysen* 23218 (BOL); Potberg, limestone hills, in sand, 19/9/1954 *Esterhuysen* 23254 (BOL); Potberg, limestone hills, rocky shelf, 19,9/1954 *Esterhuysen* 23312 (BOL); Sandy flats on S. side of Potberg, 450 ft., 19/9/1972 *Williams* 1689 (NBG, holo.); 3,3 km from Potberg farm, Potberg, 450 ft., 21/11/1973 *Williams* 1870 (NBG).

DISTRIBUTION AND BIOLOGY

Euchaetis scabricosta would appear to be a fairly rare plant. Until now it has only been found in the area lying between the Soetanyssberg and the Potberg. It does not occur in any great abundance but is rather sparsely scattered in one or two areas and can be quite easily overlooked. It is found at altitudes of from 15 to 140 m (50 to 450 feet) above sea level fairly near to the coast, growing in hard sandy soil not in deep soft soil nor on limestone. Flowering reaches a peak in September but seems to be spread over several months starting in June and ending in November. Fruits ripen mostly in November and December. At first glance it would almost appear that this flower, with its stigma and anthers in close proximity, completely hidden between the densely bearded petals, must be self-

pollinating. However the following factors may indicate that this is not the case: The disc exudes nectar apparently to attract insects. The limb of the petal spreads widely displaying a small but nevertheless obvious flower. The stigma is never really in contact with the anthers and the style lengthens to elevate the stigma only after the anthers have discharged their pollen. The pollen is somewhat sticky and does not fall upon the stigma when the anther splits open. In flowers examined, the pollen has all vanished by the time that the stigma has been raised to its highest position. The flowers are inhabited by small insects, up to 1,3 mm long, in various stages of development who apparently live on the nectar and pollen therein. These do not, however, appear to be the pollinating agents which must be very much larger. The seeds when ripe are ejected from the capsule and may be thrown up to 1 m from the plant. Regeneration would only appear to take place from seed and normally only after fires. The leaves have an odour reminiscent of cedar when crushed.

VARIATION

In this species there is some variation in the size of the leaves, those of *Esterhuysen* 23254 being the largest, but with the small amount of material available from only a few populations it is impossible at this stage to make any critical observations.

DISCUSSION

This plant may be regarded as a typical *Euchaetis*. It complies with the following criteria: *Flowers* aggregate. *Petals* transversely bearded. *Staminodes* rudimentary. *Anther* with a minute apical gland. *Disc* exceeds the ovary. *Stigma* capitate. *Style and filaments* short and glabrous. *Ovary* 5-carpellate. *Fruit* fairly short-horned.

E. scabricosta is a distinct species and, although it might seem rather like *E. burchellii* Dümmer, which also has opposite leaves, it differs in many ways. For example the leaves are shortly petiolate not sessile; they possess a single row of gland dots along the midrib not two rows, one on either side; the bracts, bracteoles and calyx lobes are all much larger; the fruits have longer horns. But above all, the leaf possesses a prominent rough midrib, a character which is referred to in the epithet *scabricosta*. *E. scabricosta* is more closely related to an undescribed species of *Euchaetis* which is found on limestone somewhat nearer to the sea coast. This species, which I propose to describe in a later paper, was considered to be conspecific with *Acmadenia laevigata* B. and W. by Sonder (1860). It has a midrib with fewer gland dots, leaves that are more obtuse, more crooked, shorter and broader and the flower heads may be resinous. These two plants occupy adjacent but different habitats, one upon hard sandy ground and the other upon limestone outcrops where the soil has a much higher pH.

ACKNOWLEDGEMENTS

In the preparation of this paper I wish to acknowledge with deep gratitude the assistance of Dr. T. T. Barnard, of the Compton Herbarium, in elucidating a host of problems in connection with the typification of Linnaean material, and also that of Dr. J. P. Rourke, Curator of the Compton Herbarium for, amongst other things, his assistance and advice in correcting the manuscript.

NOTES ON *PROTEA* IN SOUTH AFRICA

J. P. ROURKE

(*Compton Herbarium, Kirstenbosch*)

ABSTRACT

Two new species of *Protea*, *P. denticulata* and *P. vogtsiae* from the Cape Province are described, two new combinations are proposed and attention is drawn to the correct application of three other names in *Protea*.

UITTREKSEL

AANTEKENINGE OOR *PROTEA* IN SUID-AFRIKA

Twee nuwe *Protea*-spesies, *P. denticulata* en *P. vogtsiae* van die Kaap word beskryf, twee nuwe kombinasies word voorgestel en aandag word gevestig op die korrekte gebruik van drie ander name in *Protea*.

INTRODUCTION

During the course of revising *Protea* for the *Flora of Southern Africa*, it has become apparent that several as yet undescribed taxa exist. It has also been found that a number of names were incorrectly applied in the past while in other cases several familiar names will have to be relegated to synonymy and replaced by earlier epithets. Rather than deferring the publication of these necessary nomenclatural changes until the revision is complete, attention will be drawn to them in a series of miscellaneous notes published from time to time.

Protea denticulata Rourke, sp. nov.

P. scabrae R. Br. affinis, sed habitu fruticoso, caulibus erectis lignosis ad 1 m altis, foliis dense denticulatis, bracteis anguste ovatis, velutinis, carminis sordidis, marginibus distinctis badiis, receptacula anguste conico—acuminato, distinguitur.

Frutex ramosus, densus, ad 1 m altus. *Caules* erecti, crassi, lignosi, 1–1.5 cm in diam. *Folia* dense ascendentia, linearia-canaliculata, 15–25 cm longa, 5–8 mm lata; apex acuminatus, saepe uncinatus; pagina initio tricomatibus longa sericea, glabrescentes; indurata, asperis, dentibus corneis armata. *Inflorescentiae* ovoideae, 4–5 cm longae, 3.5–4 cm latae. *Receptaculum* anguste conicum-acuminatum, 1.5–2 cm altum. *Bractee* 6–7 seriatæ; bractee internae anguste oblongae vel lineares, 3–4 cm longae, 4–6 mm latae; bractee externae, anguste ovatae, 1.3–1.5 cm longae, 6–7 mm latae, velutinae, rufae-carminae sordidae;

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margines distinctos badios. *Perianthium* 2,5–3,5 cm longum, leviter adaxiale arcuatum; limbi lineares 1–1,2 cm longi, molliter sericei; apices acuminati criniti; unguis glabri, sed margines interiores tricomatibus longis sericeis fimbriatis. *Stylus* adaxiale arcuatus, 2,5–3,5 cm longus. *Stigma* lineare—filiforme, 6 mm longum.

A low, dense, much branched shrub to 1 m in height, up to 2 m in diam. *Stems* developing from a subterranean rootstock; stout and woody 1–1,5 cm in diam, erect or slightly twisted, covered with prominent leaf scars. *Leaves* densely ascending, linear-canaliculate, 15–25 cm long, 5–8 mm wide, apex acuminate, often uncinat, petiolar region terete; covered with soft silky trichomes at first, becoming glabrous with a few trichomes on the channelled surface; texture hard and wiry, surface densely covered with horny denticles. *Inflorescences* sessile, ovoid, 4–5 cm long, 3,5–4 cm wide. *Involucral receptacle* narrowly conic—acuminate, 1,5–2 cm in height, 0,8–1,3 cm wide at base. *Involucral bracts* 6–7 seriate: the innermost narrowly oblong to linear, 3–4 cm long, 4–6 mm wide, apex rounded, concave, margins thickly fimbriate; thereafter grading from oblong to narrowly ovate of the outer series, 1,3–1,5 cm long, 6–7 mm wide; outer surface of bracts dull reddish-carmine, covered with a thick velutinous indumentum; bract margins sharply delimited, chestnut brown. *Perianth* 2,5–3,5 cm long, slightly curved adaxially; limbs linear, 1–1,2 cm long, softly sericeous, apices acuminate, crinite; claws glabrous on outer surface but thickly fringed with long silky trichomes on the inner margins; tube glabrous, 0,8–1 cm long. *Anthers* 4, subsessile, terminated by a sagittate apical boss. *Style* adaxially arcuate, 2,5–3,5 cm long, tapering subterminally. *Pollen presenter* linear-filiform, 6 mm long, scarcely differentiated from the style. *Hypogynous scales* irregularly ovate, 1 mm long.

Diagnostic Characters: *P. denticulata* is allied to *P. scabra* R. Br. from which it may readily be distinguished by its shrubby growth habit with stout, erect, woody stems, up to 1 m in height. It may further be distinguished by the heavily denticulate leaves, the narrowly ovate, dull reddish-carmine, velutinous involucral bracts with their distinctive chestnut-brown margins, and the narrowly conic-acuminate involucral receptacle.

Type Material: North slopes of the Potberg at the farm Diepkloof, 19/9/1973, J. P. Rourke 1401 (NBG holo.; PRE, STE, K, MO, S, iso.).

A specimen collected on the Potberg by Dr M. R. Levyns in 1947 is the earliest record of this species known at present. Subsequent records are likewise all from the Potberg and it is now clear that *P. denticulata* is confined to the Potberg range, an isolated block of Table Mountain Sandstone which protrudes above the Bokkeveld Shales of the southern Cape coastal plain near the mouth of the Breede River. *P. denticulata* occurs in the foothills of this sandstone

"island" in north, south, east and west facing situations at elevations ranging from 120–300 m.

Where the veld has not been burnt for a number of years, the shrubby growth habit which is so characteristic of this species, is developed to its fullest extent, most mature plants reaching a metre or more in height. Repeated burning however, results in shorter stems, 30–50 cm in height, being produced from the subterranean rootstock.

The flowering period is relatively well defined; from mid-August to mid-October. By the end of October most of the inflorescences have faded and entered the fruiting stage.

SPECIMENS EXAMINED

CAPE PROVINCE—3420 (Bredasdorp): Diepkloof, Potberg, (-BC), 24/9/1966, *Williams* 910 (NBG); Between Malagas and Cape Infanta, 9/10/1959, *Middelmann* s.n. (NBG 82631); Potberg, 2/12/1965, *Williams* 639 (NBG); Diepkloof farm, hills on north side of Potberg 24/9/1966, *Rourke* 606 (NBG); Potberg, flats and lower slopes, 12/11/1954, *Rycroft* 1737 (NBG); North slopes of the Potberg at the farm Diepkloof, 19/9/1973, *Rourke* 1401 (NBG); Potberg, stony flats at south base of peak, 19/9/1954, *Esterhuysen* 23351 (BOL); Hamerkop, Potberg range, 5/10/1947, *Levy* 8432 (CT).

Protea vogtsiae Rourke, sp. nov.

Habitus latus caespitosus, folia glauca, anguste oblanceolata vel spatulata, 12–25 cm longa, 1–3 cm lata, basi in petiolum gradatim decrescentia, et limbi perianthii dense lanati, *P. vogtsiae* ex specierum affinium dividunt.

Fruticulus nanus, latus caespitosus, 20–50 cm in diam., 20–25 cm altus. *Caules* hypogaei, horizontaliter extendentes. Ramuli caespites terminales foliorum ferentes. *Folia* anguste oblanceolata vel spatulata, 12–25 cm longa, 1–3 cm lata, basi in petiolum gradatim decrescentia, glauca, obtusa, raro subacuta, pagina leviter granulata. *Inflorescentiae* globosae cyathiformes 3.5–4 cm in diam.; gemmae conicae ovatae. *Receptaculum involucre* 1.5–2 cm in diam., leviter convexum. *Bractee involucre* 4–5 seriata. Series intima oblonga spatulata, 3–3.5 cm longa, 1 cm lata, apices rotundatos concavos. Series externa, ovata vel late ovata, 7–15 mm longa, 7–10 mm lata, obtusa. Pagina externa sparsa sericea, glabrescens, viridi-flava, sordida-carmina suffusa. *Perianthium* 3–3.5 cm longum, glabrum, praeter perianthium limbum manifeste lanatum ad apicem. *Perianthium* limbi lineares, acuminati, glabri sed apices dense lanatos. *Stylus* 2.5–3 cm longus, arcuatus adaxialis contractus terminalis, leviter compressus. *Stigma* peranguste lineare vel filiforme, 5–6 mm longum, compressum, longius strorsum sulcatum. *Squamulae hypogynae* ovatae vel oblongae, 1.5 mm long interdum bifidae.

Dwarf caespitose shrublet forming rather loose tufts 20–50 cm in diam., 20–25 cm in height. *Stems* subterranean, spreading horizontally, bearing alternate, acute scales up to 5 mm long. *Flowering shoots* terminating the subterranean stems, 5–7 mm in diam., the shoots producing a crown of spirally arranged leaves at the point of emergence from the soil. *Leaves* narrowly oblanceolate to spatulate, 12–25 cm long, 1–3 cm wide, tapering to a distinct carmine tinted petiolar region; apex obtuse, very rarely subacute; glaucous, surface slightly granulate. *Inflorescences* ovoid to globose, cyathiform, 3,5–4 cm in diam. Inflorescence buds conic acute. *Involucral receptacle* 1,5–2 cm in diam., slightly convex. *Involucral bracts* 4–5 seriate, the innermost series oblong-spatulate, 3–3,5 cm long, up to 1 cm broad, apex rounded, concave, broadly obtuse; outer series ovate to broadly ovate 7–15 mm long, 7–10 mm wide, obtuse; outer surface of bracts minutely sericeous, becoming glabrescent to glabrous, margins minutely fimbriate; yellow-green suffused with dull carmine, more uniformly carmine in some specimens. *Perianth* 3–3,5 cm long, fairly straight in bud, outer surface glabrous except for the thickly lanate apices of the perianth limbs. Adaxial perianth sheath 4 mm wide proximally, tapering to almost filiform below the limbs, minutely puberulous along inner margins. Limbs 8–9 mm long, linear, glabrous or very sparsely puberulous for the greater part of their length, apices acuminate, thickly lanate. *Anthers* 4, linear, 5 mm long, terminating in an ovoid-saggitate apical boss. *Style* adaxially curved 2,5–3 cm long, slightly compressed longitudinally, tapering subterminally. *Pollen presenter* linear-filiform, 5–6 mm long, flattened, longitudinally grooved, apex obtuse. *Hypogynous scales* ovate to oblong, 1,5 mm long occasionally bifid.

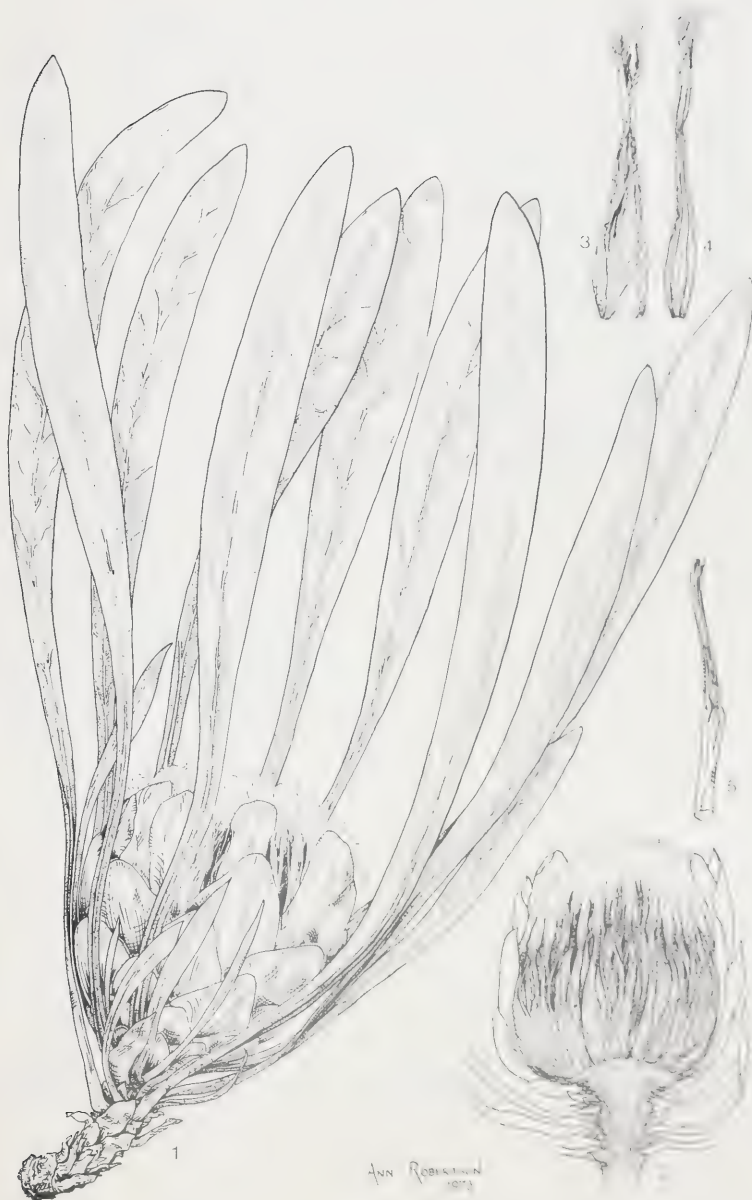
Diagnostic Characters: The loose, open, tufted growth habit, the glaucous, narrowly oblanceolate to spatulate leaves, 12–25 cm long, 1–3 cm wide, tapering to a distinct petiolar region and the thickly lanate apices of the perianth limbs at once distinguish *P. vogtsiae* from related taxa. Prior to anthesis, the conic-acute inflorescence bud with a prominently projecting white beard is a very distinctive feature of this species.

Type Material: Kouga Mountains, on the lower south slopes of Saptoukop above the farm Ouplaas, 14/8/1973, 1 100 m (\pm 3 500 ft), *J. P. Rourke 1396* (NBG, holo.; PRE, STE, K, MO, S, iso.).

Few collections of *P. vogtsiae* have ever been made, that of Dr E. J. Markötter in 1935 being the first recorded collection of this species. This most distinct and elegant little species is named in honour of Dr Marie M. Vogts who has studied

FIG. 1.

Protea vogtsiae. 1, Flowering shoot, life size; 2, inflorescence in half section, life size; 3, perianth at anthesis showing abaxial perianth segment separating—lateral view, \times 1,5; 4, perianth just prior to anthesis—adaxial view, \times 1,5; 5, pollen presenter, \times 5.



Protea for many years and whose enthusiasm and encouragement led me to enquire more deeply into the taxonomy of this fascinating group of plants.

P. vogtsiae occurs in a relatively small area at the eastern end of the Longkloof. Here it is mainly confined to the Kouga and western Baviaanskloof mountains, where its range extends from Hoopsberg in the west to Kouga Peak in the east. Scattered populations also occur on the north slopes of the Outeniqua range in the vicinity of Misgund and Haarlem. Mature plants may be from 20–50 cm in diameter. They form loose clumps with tufts of leaves developing at ground level from a very divaricate, horizontally spreading, subterranean branch system. A high degree of fire resistance characterises this species. New shoots develop from the subterranean branch system if the aerial parts are burnt off in a veld fire. Populations have been recorded at elevations of 1 000–1 500 m (3 500–5 000 ft) on rocky slopes of Table Mountain Sandstone. Within most populations a certain degree of variation in the colour of the involucre bract is evident. In some individuals the bracts are greenish-yellow, irregularly suffused with dull carmine while in others the bracts are a uniformly dull carmine to claret shade. Flowering takes place from mid-August until November but is clearly dependent on moisture availability during the winter and spring months. (Fig. 1).

SPECIMENS EXAMINED

CAPE PROVINCE—3323 (Willowmore): Hoopsberg, lower south slopes (-CB), 12/3/1966, *Rourke 408* (NBG); Haarlem, Longkloof, south side of a koppie, 11/7/1935, *E. J. Markötter s.n.* (STE 24553); Van Niekerk Heights, above Misgund Oos (-CD), 17/8/1971, *Hardick 60* (NBG); Misgund, Longkloof (-CD), 6/7/1963, *Williams s.n.* (NBG 69618); south slopes of Saptoukop above Diepte van Ellende, near Bo Kouga (-DA), 1/8/1968, *Williams 1215* (NBG); Kouga Mountains, on the lower south slopes of Saptoukop above the farm Ouplaas (-DA), 14/8/1973, *Rourke 1396* (NBG, PRE, STE, K, MO, S); Kouga mountains near Smutsberg (-DB), 4/7/1954, *H. C. Taylor 1280* (NBG); Kouga mountains, nek north of Smutsberg (-DB), 18/9/1973, *Oliver 4605* (STE). —3324 (Steytlerville): Summit of Kouga Mountain, (-CA) 20/9/1953, *H. C. Taylor 906* (NBG).

CHANGES IN NOMENCLATURE

Attention is drawn to the following name changes in *Protea*. Two new combinations are proposed and the correct usage of three other names is indicated.

Protea scolopendriifolium (Salisb. ex Knight) Rourke, comb. nov. *Erodendrum scolopendriifolium* Salisb. ex Knight, Cult. Prot.: 43 (1809)—basionym. Type: "On the arid high ground, Winterhoek," Oct., *Niven 23* (K, holo.!).

Protea scolopendrium R. Br. in Trans. Linn. Soc. Lond. **10**: 94 (1810); Meisn. in DC., Prodr. **14**: 243; Phill. & Stapf in Fl. Cap. **5**: 597 (1912). Type: Wintershoek, *Roxburgh 13* (BM, holo.!).

Protea scolopendrina St.-Lager in Ann. Soc. Bot. Lyon. **7**: 132 (1880)—nom. nud.

Protea holosericea (Salisb. ex Knight) Rourke, comb. nov. *Erodendrum holosericeum* Salisb. ex Knight, Cult. Prot.: 40 (1809)—basionym. Type: "Procumbent plant, alpine dry rocky places, Wilde River holosericeum Ms", in herb. Salisbury (K, holo.!).

Protea patens R. Br. in Trans. Linn. Soc. Lond. **10**: 82 (1810); Meisn. in DC., Prodr. **14**: 232 (1856); Phill. & Stapf in Fl. Cap. **5**: 568 (1912). Type: Based on same collection as above, "In Africa australis montibus saxosis prope Wilde River", *Niven* (in herb. Hibbert—not traced).

Protea speciosa (L.) L. var *patens* Andr. Bot. Rep. t 543 (May, 1809).

Both Brown and Salisbury cite Andrews' plate number 543 in the *Botanist's Repository* in their descriptions and both authors also cite Niven's collection from "Alpine dry rocky places, Wilde River." Although their respective epithets were based on the same collection, only the type of Salisbury's name has been traced. This specimen at Kew is clearly annotated in Salisbury's hand with the word "Holosericeum ms". (Fig. 2).

Mystery surrounded the identity of this species for a long time as for over 150 years it was known only from the type specimen and Andrews' plate. Moreover, the type locality could not be visited as it was impossible to determine the precise position of the Wilde River which could have been anywhere in the Western Cape. No such locality could be traced on either old or modern maps.

In September 1965 Miss E. E. Esterhuysen of the Bolus Herbarium collected what she considered to be a small form of *Protea barbigera* Meisn. on Sawedge Peak, near Worcester, C.P. Some years later, I had the opportunity of examining her specimens from this site and comparing them with the type specimen of *Erodendrum holosericeum* Salisb. ex Knight, which was then on loan to the Compton Herbarium from Kew. It was at once evident that Miss Esterhuysen's material (E. Esterhuysen 31161) was conspecific with *Erodendrum holosericeum* Salisb. ex Knight. Also, while studying a detailed map of Sawedge Peak, it was observed that the farm at the north west base of the Rabiesberg-Sawedge Peak complex was named "Wilgerivier". Many of Niven's collecting localities on his field tickets are phonetically spelled or have their spellings so distorted (e.g. Jackall Flyberg = mountain at Jakkalslei) that it is not inconceivable that Wilde River as recorded by Niven is a corruption of Wilgerivier. The fact that Niven also collected the very narrow-leaved form of *Protea canaliculata* (Andr.) St. Wilde River adds weight to the argument as this particular form is very localized

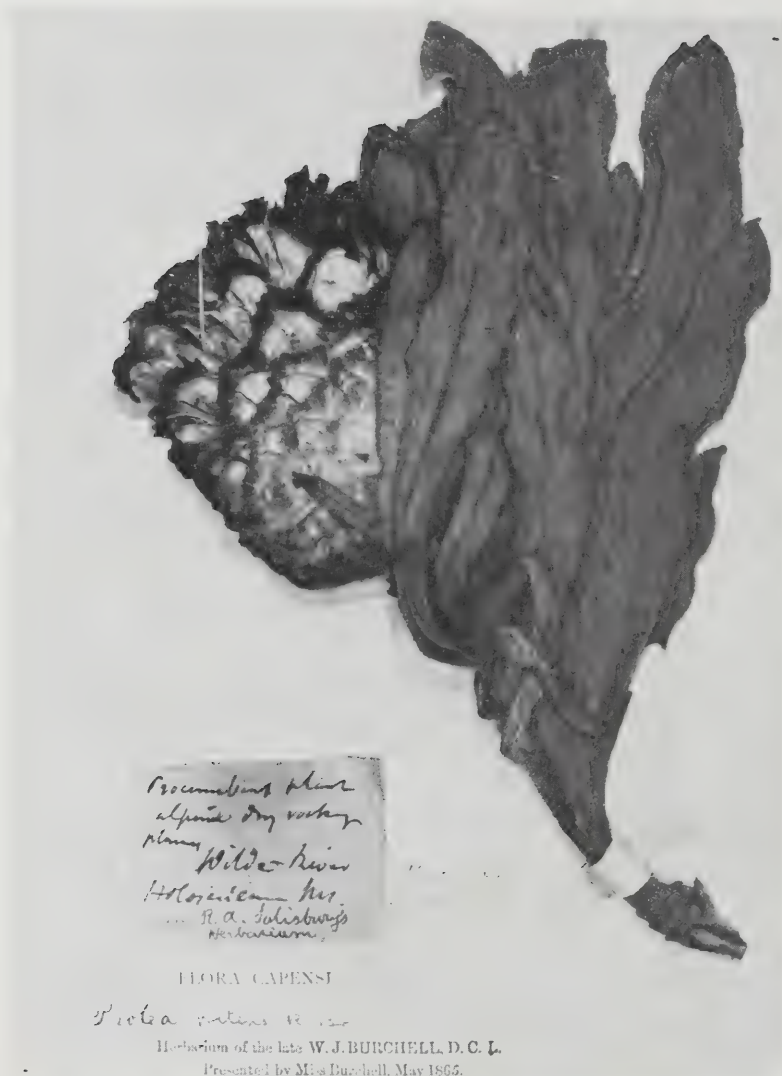


FIG. 2.

Type specimen of *Protea holosericea*, herbarium of the Royal Botanic Gardens, Kew.

in the Sawedge Peak—Koo—Montagu area and could not have been collected elsewhere. It is therefore my considered opinion that the site on Sawedge Peak from which Esterhuysen 31161 was collected in 1965 could, in all probability, be the same as that visited by Niven at least 160 years before.

SPECIMENS EXAMINED

CAPE PROVINCE—3319 (Worcester): Sawedge Peak, east of Keeromsberg (-DA), Sept., Esterhuysen 31161 (BOL, NBG); Alpine dry rocky places, Wilde River, Niven *s.n.* (K).

Protea acuminata Sims, in Curtis's bot. Mag.: t. 1694 (1814); Poir., Encycl. Meth. Bot. Suppl. 4: 562 (1816); Roem & Schult., Syst. Veg. 3: 351 (1818). Type: Curtis's bot. Mag. t. 1694.

Protea cedromontana Schltr. in Bot. Jb. 27: 109 (1899); Phill. & Stapf in Fl. Cap. 5: 592 (1912). Type: Ezelbank, in sabulosis, 2/9/1896, Schlechter 8808 (B, lecto.!; K, SAM, PRE, iso!).

The colour plate by Sydenham Edwards in Curtis's Botanical Magazine clearly and unambiguously depicts a species of *Protea* hitherto known as *P. cedromontana* Schltr. The painting was made from a specimen flowering in Lee and Kennedy's Nursery, Hammersmith, in March 1812. It is difficult to see why Phillips and Stapf listed *P. acuminata* Sims as an imperfectly known species in their account of *Protea* for the *Flora Capensis*. One can only assume that, had they been acquainted with living material, this oversight would not have occurred.

Protea subulifolia (Salisb. ex Knight) Rourke, comb. nov. *Pleuranthe subulifolia* Salisb. ex Knight, Cult. Prot.: 50 (1809)—basionym. Type: Mountains near Rivier Zonder End, Niven *s.n.* (K, holo!).

Protea virgata Andr., Bot. Rep. t. 577 (Sept. 1809), non Thunb. (1803). Type: Plate 577 in Andr., Bot. Rep.

Pleuranthe ericaefolia Salisb. ex Knight, Cult. Prot.: 50 (1809). Type: Swellendam, Masson (not traced).

Protea acerosa R. Br. in Trans. Linn. Soc. Lond. 10: 95 (1810); Edwards, Bot. Reg. t. 531 (1819); Meisn. in DC., Prodr. 14: 246 (1865); Phill. and Stapf in Fl. Cap. 5: 607 (1912). Type: Africa australis, Masson *s.n.* (BM, holo!).

Protea abietina Buek. ex Meisn. in DC., Prodr. 14: 246 (1856)—nom. nud.

Despite the fact that no type material of *Pleuranthe ericaefolia* has yet been traced, the inclusion of this name in the synonymy of *P. subulifolia* is considered justified as the description clearly refers to the short leaved form of this species.

Protea canaliculata Andr., Bot. Rep. t. 437 (1806). Type: Plate 437 in Andr., Bot. Rep.

Erodendrum paeoniflorum Salisb. ex Knight, Cult. Prot.: 46 (1809)—nom. superf. Type: As for *P. canaliculata*.

Protea harmeri Phill. in Kew. Bull **1911**: 83 (1911); Phill. & Stapf in Fl. Cap. **5**: 593 (1912); Phill in Flower. Pl. S. Afr. **5** t. 192 (1925). Type: Hills near Matjiesfontein, Aug. 1905, *S. F. Hamer s.n.* (K, holo.!).

Brown and several succeeding monographers of *Protea* misinterpreted Andrews' plate and description which depict and describe a species with an erect growth habit and deep crimson to claret coloured bracts. The error is attributable to Robert Brown who, in his account of *P. canaliculata* Andr., cites a specimen of the narrow leaved form of *Protea tenax* (Salis.) R. Br. collected by Niven in the Longkloof. Subsequent authors, assuming Brown's identification of the Niven specimen to be correct, named future collections by matching them against this specimen instead of comparing them with the type illustration by Andrews. The name *Protea canaliculata* Andr., should now be applied to the species presently known as *P. harmeri* Phill.

DUTHIELLA, 'N NUWE GENUS VAN DIE IRIDACEAE

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UITTREKSEL

Duthiella, 'n nuwe monotipiese genus van die Iridaceae, tribus Ixieae, word beskryf, gegrond op *Syringodea linifolia* Phill. Sy knoltunicae, unifasiale blare, pollen, chromosome en saadhuidstruktuur toon dat dit nader verwant is aan *Tritonia* of *Sparaxis* as aan *Syringodea*.

ABSTRACT

DUTHIELLA, A NEW GENUS OF THE IRIDACEAE

A new monotypic genus of the Iridaceae, tribe Ixieae, based on *Syringodea linifolia* Phill., is described. The corm tunics, unifacial leaves, pollen, chromosomes and structure of the testa indicate that it stands nearer *Tritonia* or *Sparaxis* than to *Syringodea*.

INLEIDING

Tydens 'n resente hersiening van die genus *Syringodea* het dit geblyk dat een spesie, *S. linifolia* Phill., nie in *Syringodea* tuishoort nie en ook nie in enige van die ander genera van die Iridaceae tuisgebring kon word nie. Daarom word dit hier as 'n nuwe monotipiese genus beskryf. Dit word vernoem na dr. A. V. Duthie, die eerste dosent in Plantkunde aan die Victoria-Kollege, later die Universiteit van Stellenbosch.

Duthiella De Vos gen. nov. Iridacearum, e *Syringodea linifolia* Phill., in Ann. S. Afr. Mus. 9: 125 (1913), composita.

Planta parva, surculo deciduo, cormo ovoideo vel subgloboso, tunicis ex fibris reticulatis tenuibus constantibus. *Caulis* et *pedunculi* perbreves, *vaginis* foliorum subterranei obtecti. *Folia* plura, rosula basilari, equitantia, pro parte majore unifacialia, linearia mollia. *Inflorescentia* cymosa, ramis perbrevibus, unusquisque in floro uno subsessile supra bracteam bracteolamque terminans. *Bractea* *vaginis* foliorum subterranea obtecti, linearis integra acuminata alba membranacea, bracteolam aequans, vel interdum longior apice viridi unitateali praedita. *Bracteola* obtecti linearis membranacea alba apice bitido. *Flos* regularis et symmetricus, plus minusve hypocrateriformis, basi subterranea. *Tubus perigonii* ca. 3-plo segmentis longior, rectus tubiformis, apicem versus parum dilatatus; *segmenta* elliptica. *Stamina* discreta equilateralia exserta, in fauce tubi perigonalis inserta; *filamenta* recta; *antherae* fere basifixae, polline 1-sulcato exino punctitegillato, tegillo verrucis praedito. *Stylus* rectus, ramis brevibus

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indivisis filiformibus; *stigmata* tria terminalia brevica. *Capsula* clavata, basi tenui infertili, apice loculicida; *semina* numerosa globosa laevia nitida brunnea.

Species typica: *Duthiella linifolia* (Phill.) De Vos comb. nov.

Plante klein kruidagtige geofiete met 'n gerokte knol en 'n spruit wat in die droë seisoen verdroog. *Knol* nagenoeg simmetries, ortotroop, eivormig tot byna bolronde, met tunicae bestaande uit fyn-retikulate bruin vesels. *Stingel* en *pedunculi* gereduseerd, baie kort, ondergronds verberg onder blaarskedes. *Basale skedeblore* 1–2, bifasiaal, membraneus, die tweede soms met 'n groen unifasiale top. *Loofblare* verskeie, rydend, in 'n grondstandige, min of meer twee-ryge roset, grootliks unifasiaal, lineêr, sag, naak. *Bloeiwyse* bepaald, veelvertak, elke tak (pendunculus) baie kort, in die oksel van 'n hoër loofblaar, met 'n enkele terminale, byna sittende blom bo 'n skutblaar en skutblaartjie. *Skutblaar* bifasiaal, lineêr, akuminaat, gaafrandig, membraneus, wit, sag, die rande vry, net so lank soos die skutblaartjie of soms langer met 'n groen unifasiale top. *Skutblaartjie* lineêr, sag, wit, gesplete aan die top. *Blom* aktinomorfe, naasteby trompetvormig, geel, met die basis ondergronds verberg. *Blomdebuis* ongeveer driemaal langer as die segmente, reguit, buisvormig, aan die top effens verbreed; *segmente* ellipties, die buitenste segmente effens langer as die binneste. *Meeldrade* vry, simmetries rondom die styl gerangskik, uitgestoot, in die keel van die blomdek ingeplant; *helmdrade* dun, regop; *helmknoppe* lineêr, byna basifiks, met 1-sulkate pollen, die tegillum fyn-punktaat en met onreëlmatige verrucae beset. *Vrugbeginsel* met baie saadknoppe; *styl* filiform, reguit, langer as die blomdebuis, met kort onverdeelde filiforme styltakke; *stempels* drie, terminaal, kort. *Doosvrugte* knuppelvormig, met die basis smal en onvrugbaar, hokspletig aan die top; *sade* talryk, bolronde, glad, blink, bruin.

Hierdie monotipiese genus kom voor in die Republiek van Suid-Afrika ongeveer tussen 23° en 27°90' oosterlengtegrade en 25° en 29°45' suiderbreedtegrade, in die streek waar die Transvaal, Vrystaat en Bechuanaland aanmekaar grens.

Dit hoort tot die tribus Ixieae en word gekenmerk deur 'n simmetriese, afgeronde knol met 'n fyn retikulate veselomhulsel, verskeie grondstandige, rydende, lineêre, sagte blare, 'n baie kort, ondergronds verbergde stingel en pedunculi, 'n bepaalde bloeiwyse met aktinomorfe, geel (soms wit?) blomme met 'n baie lang, reguit blomdebuis, die blombasis ondergronds verberg, en met onverdeelde styltakke, en ook deur doosvrugte met 'n effens onegalige eksokarp en vele ronde gladde sade.

Die knolontwikkeling is soos tipies by die Ixieae: die ongeveer vier basale internodia van die spruit swel op om die nuwe knol te vorm (Fig. 1). 'n Loofblaar is vasgeheg aan elke knoop op die knol en die tunicae is die ou oorblywende loofblaarbasisse waarin netwerkvormige sklerenchiemstringe vroeg ontwikkel.

Die genus verskil van *Syringodea* waaruit dit afgeskei is, in sy simmetriese knol met retikulate tunicae—die tipe van die spesie is sonder 'n knol en ongetwyfeld sou Phillips (1913) die spesie nie in *Syringodea* geplaas het as hy die knol kon ondersoek het nie—verder in sy unifasiale blare wat geen tannien bevat nie, in sy skutblaar en skutblaartjie beide met vrye rande, sy 1-sulkate pollen, geel blomkleur en gladde sade. Kenmerke wat met dié van *Syringodea* ooreenstem, is die kort, ondergonds verbergde stingel en pedunculi, bepaalde bloeiwyse, aktinomorfe blomme met lang reguit blomdekbuis, ondergrondse blombasis en

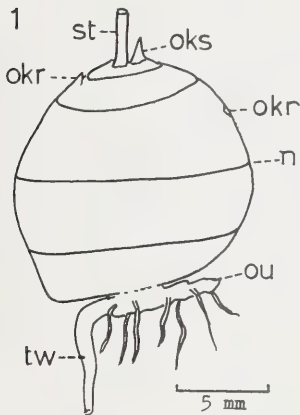


FIG. 1.

Knol van *Duthiella linifolia*, die tunicae verwyder: n, nodus; okr, rustende okselknop; oks, okselknop vir aanstaande jaar se spruit; ou, vorige leë knol; st, stingelbasis; tw, trekwortel.



FIG. 2.

Kariotipe van *Duthiella linifolia*, uit 'n wortelpunt.

onverdeelde styltakke. Die lengte van die blomdekbuis en die kort stingel word nie as van belang beskou by die diagnose van genera nie, omdat variasie dikwels binne genera voorkom, bv. by *Babiana*, *Ixia*, *Gladiolus*, *Romulea* (vgl. Lewis, 1954 p. 93).

'n Bepaalde bloeiwyse met basipetale blomvolgorde kom by die tribus Ixieae selde voor en slegs by die subtribus Crocineae (*Romulea*, *Syringodea*, *Crocus*), by enkele spesies van *Hesperantha* en *Geissorhiza* (Lewis, 1954 p. 105), een spesie van *Anomatheca* (Goldblatt, 1972), en by *Duthiella*. Hierdie tipe bloeiwyse moes verskeie male in die Ixieae ontwikkel het: by *Hesperantha*, *Geissorhiza* en *Anomatheca* deur reduksie van die tipiese are van daardie genera, en by die subtribus Crocineae moontlik uit die veelvertakte bloeiwyse van die primitiewe Iridaceae

(vgl. Haeckel, 1931; Lewis, 1954). Die bloeiwyse van *Duthiella* stem in 'n mate ooreen met dié van *Romulea* en *Syringodea* (de Vos, 1972; 1974): die hoofas en syasse, ook van die tweede orde, eindig elk in 'n enkele terminale blom wat sittend of byna sittend bo 'n skutblaar en skutblaartjie gedra word. Verskille kom soms egter voor, wanneer 'n syas deur hervertakking tot vier blomme kan dra, wanneer die volgorde van die antese effens verskil (Fig. 3, 4), en wanneer die

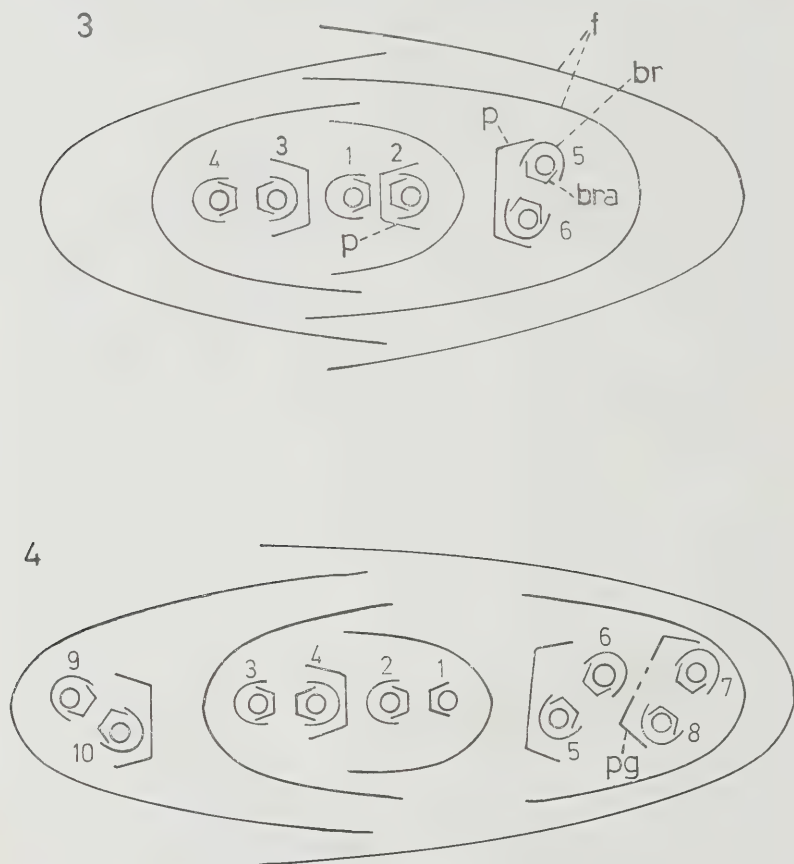


FIG. 3, 4.

Bloeiwyses van *Duthiella linifolia*, diagrammatiese grondplanne om variasie te toon: br, skutblaar van blom; bra, skutblaartjie van blom; f, loofblaar; p, profil (voorblaar); pg, 'n twee verdeelde voorblaar; 1-10, blomme in die volgorde van antese.

skutblare van die boonste een of twee blomme varieer van bifasiaal en halfdeurskyend by sommige plante tot dubbeld so lank as die vorige, met 'n groen unifasiale tophelfte wat bo die grond uitsteek by ander; verder mag die skutblaar en skutblaartjie van een of meer blomme afwesig wees (Fig. 4, blom 1). Veral die laasgenoemde variasie mag miskien aandui dat die bepaalde bloeiwyse by *Duthiella* deur reduksie van 'n vertakte aar geëvolveer het (vgl. Goldblatt, 1972). Die boonste een of twee blomme is al wat oorgebly het van die hoofas van die oorspronklike aar en die ander blomme staan op sytakke daarvan.

Die simmetriese knol met retikulate tunicae, die rydende, lineêre sagte blare en die gladde ronde sade, stem ooreen met dié van sekere genera van die tribus Ixieae, t.w. *Freesia*, *Anomatheca*, *Ixia*, *Sparaxis* en *Tritonia*, wat Lewis (1954) in die subtribus Ixiineae saamgevat het, maar wat Goldblatt (1971) in drie subtribusse verdeel (Freesiineae, Ixiineae en Tritoniineae). *Duthiella* verskil van hulle in sy skutblaar en skutblaartjie, sy kort, gereduseerde stingel en, behalwe vir die een spesie van *Anomatheca*, in sy bepaalde bloeiwyse. Van *Freesia*, *Anomatheca* en *Tritonia* verskil dit verder in sy aktinomorfie blomme met die meeldrade reëlmatig gerangskik; van *Freesia* en *Anomatheca* ook in sy onverdeelde styltakke en drie stempels; van *Tritonia* in sy terminale kort stempels en toegerolde filiforme styltakke; van *Anomatheca* in sy gladder doosvrug; en van *Tritonia* en *Ixia* (die ander genera is nie ondersoek nie) in die afwesigheid van tannienbevattende selle in die loofblare.

Die saadstruktuur van *Duthiella* (Fig. 5), *Freesia*, *Sparaxis* en *Tritonia* is vergelyk. Hul gladde saadhuide stem anatomies grootliks ooreen in die besit van 'n dikwandige oorblywende buite-epidermis met 'n korrelrige inhoud en 'n gladde dik kutikula bo die dik boonste periklinale selwand. Die res van die buite-integument is platgedrukte selle. Van die binne-integument bly net een laag, soms leë dunwandige (bv. *Freesia*, *Sparaxis*) of dikwandige, selle oor. Die tweede kutikula tussen die twee integumente en die derde binne die tweede integument is baie dun. Nucellusoorblyfsels is afwesig. Die endospermselle is, soos by die reeds ondersoekte Iridaceae, dikwandig (hemisellulose) en gevul met aleuron en olie. Van die drie genera stem die saad van *Tritonia* meeste ooreen met die van *Duthiella* waar die binne-integumentselle taamlik dikwandig is, en 'n inhoud besit.

Die 1-kolpate, punktitegillate pollen van *Duthiella* (Fig. 6), met aparte verrucae op die tegillum, is tipies vir die Ixieae (Schulze, 1970) en gee nie uitsluitel oor sy verwantskappe nie, behalwe dat dit toon dat die genus nie saam met *Syringodea* behoort nie, waar die pollen rond en nie-aperturaat is (de Vos, 1974).

Die diploiede aantal chromosome vir *D. linifolia*, verkry uit die materiaal *Malan 10* van Bloemhof, is 20 (Fig. 2). 'n Voorbehandeling met 0,001 mol 8-hidroksikwinolien vir vier uur het die beste resultate gelever. Die chromosome

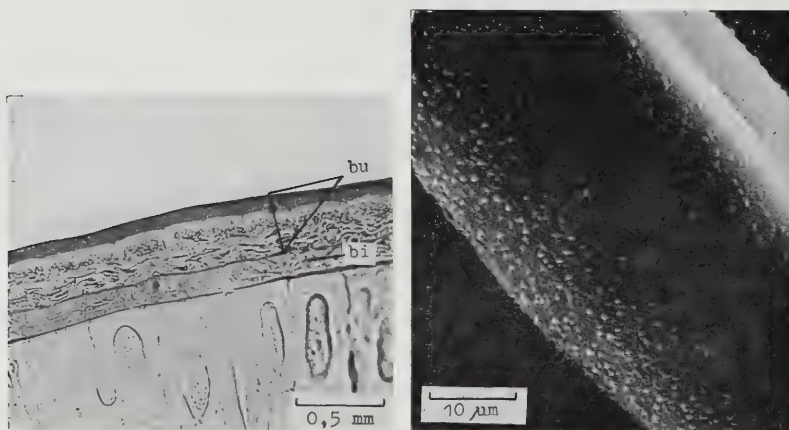


FIG. 5.

Snee deur die saadhuid en endosperm van *Duthiella linifolia*: bu, buite-integument; bi, binne-integument.

FIG. 6.

Skandeer-elektron-mikrofoto van deel van 'n pollenkorrel van *Duthiella linifolia*.

is 1,5–4 μm lank; die vier langstes het submediane sentromere en die kleiner chromosome se sentromere varieer van submediaan tot subterminaal. Twee van die langes het satelliete. Die kariotipe stem min of meer ooreen met die van die Tritoniineae en Freesiineae van Goldblatt (1971), behalwe dat by die meeste genera van die Tritoniineae daar 22 chromosome is en by beide die subtribusse die chromosome oor die algemeen subterminale sentromere besit, volgens Goldblatt (1971).

VERWANTSKAPPE

As al die gegewens, morfologies, anatomies en sitologies, in ag geneem word, blyk dit dat *Duthiella* nie as deel van enige van die bogenoemde genera beskou kan word nie, en dat dit moontlik die naaste staan aan *Tritonia* of *Sparaxis*.

Daar is 'n enkele spesie:

Duthiella linifolia (Phill.) De Vos comb. nov.

Syringodea linifolia Phill. 1913 p. 125—basioniem.

Holotipe: SAM 20664, sonder vindplek of versamelaar, in SAM.

Benewens die genuskenmerke toon die spesie die volgende kenmerke: *Plante* 6–15 cm hoog. *Knol* 10–15 mm in deursnee; die fyn-retikulate tunicae bruin tot ligbruin, met 'n kragie tot 5 mm hoog om die spruit. *Stingel* 8–15 mm lank,

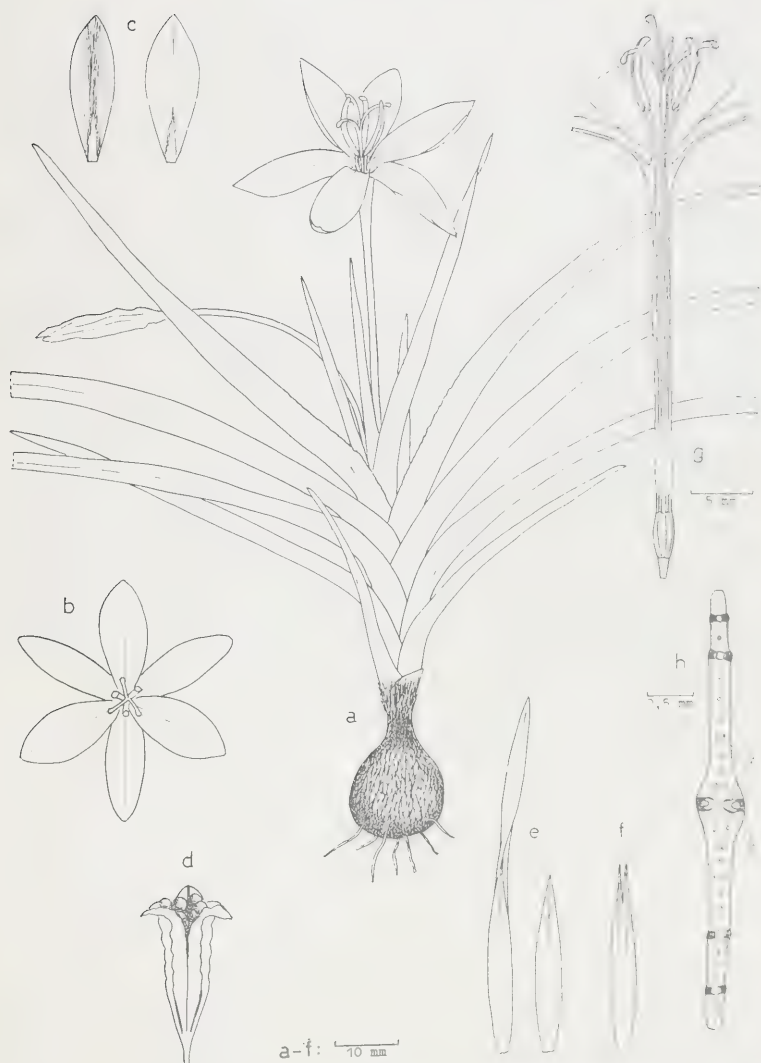


FIG. 7.

Duthiella linifolia (Malan 10): a, die plant; b, blom van bo; c, buitenste (links), en binneste (regs) blomdeksegmente van onder; d, doosvrug; e, twee tipes skutblaar; f, skutblaar; g, androecium, gynoecium en blomdekbasis; h, dwarsnee deur 'n loofblaar; i, sklerenchiemring; v, vaatbundels.

verberg. *Loofblare* 6–9, meestal seklervormig gebuig en spreidend of soms regop, 4–20 cm lank, 1,5–5 mm breed, naak, skerp, sonder tannien, met een prominente aar in die vars toestand sigbaar en tot 5 prominente are wanneer droog, die boonste rande soms fyn gekartel; die onderste blare met breë geslote blaarskedes, die boonste blare korter en smaller. *Pedunculi* ca. 1 mm lank, ondergronds verberg tussen die blaarskedes. *Skutblaar* verberg deur die blaarskedes, wit, halfdeursigtig, 25–30 mm lank, ca. 4 mm breed, nie tot die helfte van die blomdekbuis reikend; of tot 65 mm lank, met die tophelfte groen en unifasiaal. *Skutblaartjie* 25–30 mm lank, halfdeurskynend, vlak- tot diep-gekeep. *Blomme* een tot verskeie, min of meer die een na die ander verskynend, 70–120 mm lank. *Blomdek* met die soom van die horisontaal spreidende segmente 25–40 mm in deursnee; *blomdebuis* 40–70 mm lank, ca. 1 mm in deursnee, effens breër aan die top; segmente konkaaf, skerp tot halfstomp of soms stomp, 12–25 mm lank, 4–8 mm breed, geel (Roy. Hort. Soc. Kleurkaart no. 14B) (soms wit?), die buitenste segmente bruin-pers agter of met bruin-rooi are, effens smaller en langer as die binneste segmente. *Meeldrade* regop, geel; *helmdrade* 4–6 mm lank, naak; *helmsknoppe* 5–7 mm lank, effens spreidend en met ingebuigde toppe; pollen liggeel, 95–105 μm \times 40–48 μm (droog). *Vrugbeginsel* 2,5–5 mm lank, effens driehoekig, effens smaller na onder, op 'n 1,5 mm vrugsteeltjie; *styl* 45–75 mm lank, regop; die styltakke 3–6 mm lank, spreidend, liggeel, met ingerolde toegevoorde rande; *stempels* terminaal, ca. 1 mm lank, effens breër as die styltakke, papilleus op die rande, tussen die helmsknoppe uitstekend. *Doosvrugte* 20–25 mm lank, met 'n smal basis wat 'n pseudo-pedisel vorm, oopsplitsend in die top-kwart tot -derde wat bo die grond verskyn; *sade* 2 mm in deursnee. *Chromosoomgetal* $2n = 20$.

TRANSVAAL. 2725 (Bloemhof): Bloemhof-meent (DA), *Tardrew* s.n. (PRE, K). Golfbane (DA), *Malan 10* (STE).

ORANJE-VRYSTAAT. 2726 (Odendaalsrust): Kommandodrif (AC) op wal van die Vaal, *Acocks 24202* (PRE, K). 2727 (KROONSTAD): Vlei naby klooster (CA), *Pont 462* (PRE).

KAAPLAND. 2525 (Mafeking): Meshesh naby Mosita, *Brueckner 248* (PRE). 2624 (Vryburg): Vryburg (DC), *Henrici 151* (PRE). 2723 (Kuruman): Cotton End (AB), *Esterhuysen 2250* (BOL), Batlharo (AD), *Silk 237* (BOL). 2823 (Griekwastad): Griekwastad (CC) algemeen op kalkveld, *Wilman SAM 46641*. Omtrent 5 ml W. van Postmasburg (AC), *Pole-Evans 52* (PRE, K). 2824 (Kimberley): Warrenton (BB), *Adams 6* (GRA), *BOL 16203*. 3 ml N. van Riverton (BD), *Leistner 1910* (PRE). Barkly-Wes, Mamotlalokasie (DA), *Acocks 460* (BOL, PRE, BM). Klipdrif; *Moran BOL 16520* (BOL, GRA). 2923 (Douglas): Douglas (BB); *Marloth 6478* (PRE).

BECHUANALAND sonder nadere vindplek, *Galpin s.n.* (BOL).

Blomtyd Maart tot Mei of soms tot Junie. By plante wat in Stellenbosch aangeplant is, open die blomme vir twee tot vier dae om ongeveer 13.00 h; hulle bly oop tot donker of kort ná donker, afhangende van die temperatuur. Die bestuiwing is hoofsaaklik deur dag-vlieënde insekte. Nektar wat in die septale nektarkliere gevorm word, vergader in die blomdebuis en stoot met kapillariteit op in die lang smal buis tot byna bo. Die blomme kan dus ook deur insekte met kort monddele bestuif word. Vogel (1954) egter meld dat die blomme in Bechuanaland wit is en deur pylstertmotte bestuif word.

DANKBETUIGING

My hartlike dank gaan aan die kurators en direkteure van die herbaria BOL, PRE, GRA, SAM, BM en K wat materiaal vir die ondersoek geleen het, en aan die WNNR, Afdeling Elektronmikroskopie van die Fisiese Navorsingslaboratorium, vir die neem van mikrofoto's van die pollen. Ek is ook dank verskuldig aan mev. A. Mauve en mej. M. Thompson vir hul gewaardeerde raad, aan prof. P. G. Jordaan vir die oorlees van die manuskrip, en veral ook aan prof. M. E. Malan wat vars materiaal vir die ondersoek gesoek het tot sy dit eindelik by Bloemhof gevind het.

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A NEW SPECIES OF *SUTERA* (SCROPHULARIACEAE)

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(*Compton Herbarium, Kirstenbosch*)

ABSTRACT

A new species of *Sutera* from the north western Cape, *Sutera esculenta* Bond is described.

UITTREKSEL

'N NUWE SOORT *SUTERA* (SCROPHULARIACEAE)

'n Nuwe soort *Sutera* van die Noord-Wes-Kaap, *Sutera esculenta* Bond word beskryf.

INTRODUCTION

This species appears to be extremely localized in distribution according to present records. In spite of its long flowering period, May to September, only three collections appear to have been made. It was first collected by Mr. B. Maguire in 1952 but it was not until 1973 that Mr. H. Hall collected it on two occasions. Mr. Hall has been responsible for collecting many new and interesting species from the Calvinia district.

Sutera esculenta Bond sp. nov. affinis *S. canescens* Hiern sed tubo corollae longo et foliis crassis distinguitur.

Suffrutex perennis, basin lignosus, rami divaricati, ad 20 cm altus sed saepe brevissimus, ubique dense glandulosus-puberulus. *Folia* opposita sed quasi-fasciculata, ovato-ovala, crenata, basis cuneata ad 11 mm longa; bracteae foliis similes sed minores. Flores axillares, subterminales, pauci; pedunculi 4-20 mm. bracteis longiores, uniflori; calyx 5-partitus, lobi lineari-spathulati. 4-5 mm longus; corolla albida, fauce atropurpurea, 18-21 mm longa, tubus corollae calyce 2-3-longiore, cylindricus, apex breve gibbosus; lobi oblongi 6 mm × 2 mm capsula ovoidea, subacuta 6-8 mm longa.

A perennial undershrub, woody at base, much branched, up to 20 cm high but often stunted due to grazing; densely glandular-puberulous in all parts. *Leaves* opposite or quasi-fasciculate, ovate-oval, cuneate at base, crenate, up to 11 mm long, decreasing in size upwards; petiole 1-4 mm long. *Bracts* leaf-like but smaller. *Flowers* axillary, subterminal, not numerous; peduncles 4-20 mm long, longer than the bracts, 1-flowered; calyx 5-partite with linear-spathulate lobes 4-5 mm long; corolla white with maroon markings in throat; tube 18-21

mm long, 3 to 4 times longer than the calyx, cylindrical, slightly dilated and curved at apex, sparsely glandular-puberulous; lobes oblong, obtuse 6 mm \times 2 mm; stamens and style included. *Capsule* ovoid, subacute, minutely glandular-puberulous, 6–8 mm.

Diagnostic characters: *Sutera esculenta* is most closely allied to *S. canescens* Hiern but is distinguished by its long corolla tube and thick leaves. It is obviously heavily grazed, hence its specific epithet.

Type material: CAPE—3120 (Calvinia): Farm Langfontein, 55 km east of Calvinia, east slope of stony dolerite koppie (–CA), 26th September 1973, *H. Hall* 4448 (NBG holo.; PRE, STE, K, MO, iso.).

Specimens Examined:

CAPE—3119 (Calvinia); 35 km N. of Calvinia (–BD), Sept., *B. Maguire* 1979 (NBG); 3120 (Calvinia): Farm Langfontein, 55 km S.E. of Calvinia (–CA), May, *H. Hall* 4252 (NBG); Sept., *H. Hall* 4448 (NBG).

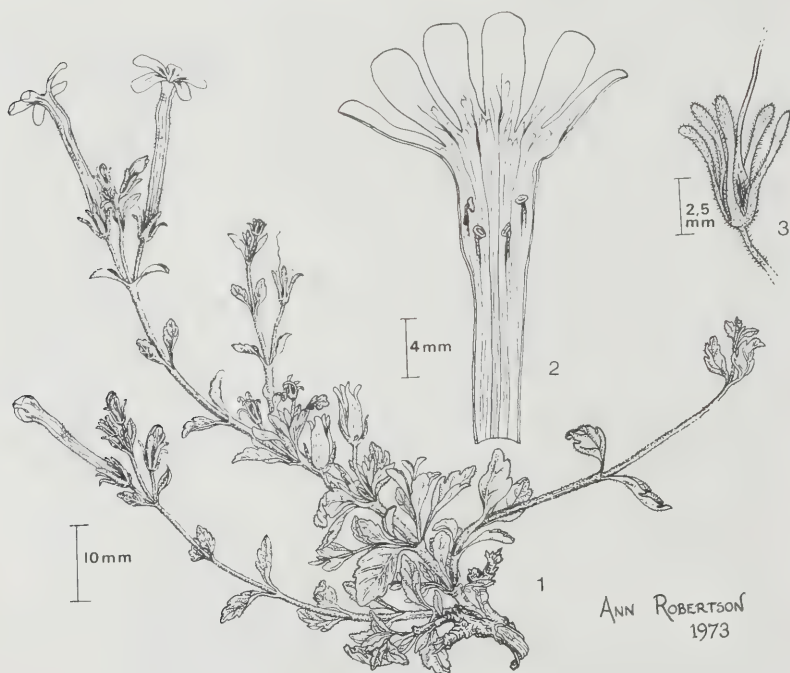


FIG. 1.

Sutera esculenta Bond.

1. Flowering shoot 10 mm. 2. Longitudinal section of flower 4 mm. 3. Calyx 2,5 mm.

PYRRHOPAPPUS TARAXACOIDES, A SYNONYM OF TARAXACUM FULVIPILLIS

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ABSTRACT

It is suggested that *Pyrrhopappus taraxacoides* DC. and *Taraxacum fulvipillis* Harv. are conspecific and that *Pyrrhopappus taraxacoides* is therefore not a disjunct South African species of an otherwise wholly American genus.

UITTREKSEL

PYRRHOPAPPUS TARAXACOIDES, 'N SINONIEM VIR TARAXACUM FULVIPILLIS

Dit word voorgestel dat *Pyrrhopappus taraxacoides* DC en *Taraxacum fulvipillis* Harv. konspesifiek is en dat *Pyrrhopappus taraxacoides* dus nie 'n disjunkte Suid-Afrikaanse soort van 'n andersinds volledig Amerikaanse soort is nie.

As a result of a systematic study of the genus *Pyrrhopappus* (Compositae, Cichorieae) (Northington, 1974), a curiosity concerning the status of *Pyrrhopappus taraxacoides* DC. was encountered. De Candolle (1838) described *P. taraxacoides* as a perennial species occurring in South Africa specifically in the Cape area, "ad Berg et Zwart Key" which is the type locality for this species collected by Drège. The remaining described taxa for this genus, however, are restricted to the southeast and southwest United States and parts of Mexico, thus, making the African species an extreme disjunct at best. An examination of microfilm of de Candolle's type specimen readily convinced me that it was not a *Pyrrhopappus*. Although this African species was treated as an excluded species in some North American treatments (Gray, 1888; Torrey & Gray, 1843; Benthams & Hooker, 1873), Harvey (1864) made no mention of the taxon in his treatment of the Compositae of South Africa. He did, however, describe *Taraxacum fulvipillis*, the type also from a Drège collection, from a locality near that of the type specimen of *Pyrrhopappus taraxacoides*. His description includes "pappus tawny" which suggests a similarity to *Pyrrhopappus*. This coincidence in addition to the de Candolle description (and the microfilm of his type specimen) strongly suggest the possibility that *Pyrrhopappus taraxacoides* and *Taraxacum fulvipillis* are conspecific.

Drège (1844) lists in his book of collecting stations No. 24 as being "Zwischen Los-Tafelberg und Zwartkey" (the type locality for *Pyrrhopappus taraxacoides* DC.); however, there is nothing in his record of specimens listed there that could have been a *Pyrrhopappus* or *Taraxacum*. At station 27, however, which is only a few miles from 24, reference to a collection of *Hypochaeris* 6176 is made for the locality "Zwischen Los Tafelberg und Wilschutsberg." Harvey used this specimen, Drège 6176, as his type for *Taraxacum fulvipilliss*. If, as is suggested by Dr. Rourke (pers. comm.), Drège sent a collection of this plant (from station 27) to de Candolle with a collection label for the locality at station 24, both de Candolle and Harvey would have had specimens of the same material and simply described them in different genera. Apparently, such a clerical error on the part of Drège is not uncommon (Rourke, pers. comm.). This would then make de Candolle's *Pyrrhopappus taraxacoides* conspecific with Harvey's *Taraxacum fulvipilliss*. Attempts to obtain the type of *T. fulvipilliss* from Sonder's Herbarium in Stockholm (S) have so far proved unsuccessful; however, a comparison of this material with the DC. type on microfilm might not prove completely reliable anyway due to the obvious difficulties of such an effort.

Davy (1935) has suggested that *T. fulvipilliss* is conspecific with a south circum-polar species, *Taraxacum magellanicum* Comm., but whichever is the correct specific epithet, I feel certain the hitherto little-mentioned *Pyrrhopappus taraxacoides* is in truth conspecific with *Taraxacum fulvipilliss* and therefore not an unexplicable disjunct of *Pyrrhopappus*.

The synonymy of these two species would, then, be as follows: ***Taraxacum fulvipilliss*** Harv. Harv. & Sond. Fl. Cap. 3: 257 (1865). *Pyrrhopappus taraxacoides* DC. Prod. 7: 144 (1838).

I would like to gratefully acknowledge Dr. J. P. Rourke for his assistance with some of the South African literature and especially his knowledge of J. F. Drège's collecting habits.

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A CHEMOTAXONOMIC STUDY OF TWELVE SPECIES OF THE FAMILY LORANTHACEAE

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ABSTRACT

The Loranthaceae is a taxonomically difficult family and the generic and specific limits and relationships of several members are in dispute. In an attempt to gain a clearer understanding of the relationships between the taxa, a chemotaxonomic study was carried out, an approach that has recently been used in a number of other families. Initially, a method of extraction and separation of phenolic compounds by paper chromatography is determined that is suitable for use with *Viscum rotundifolium* Linn. f. Using this technique, the phenolic composition of twelve species of the Loranthaceae is examined and compared, thus showing taxonomic relationships between these species with respect to this class of compounds. Suggestions are made as to the possible significance of the use of these substances in studies of the family.

UITTREKSEL

'N CHEMOTAKSONOMIESE STUDIE VAN TWAALF SPESIES IN DIE FAMILIE LORANTHACEAE

Die Loranthaceae is taksonomies 'n moeilike familie. Die onderskeid tussen genera en spesies is in 'n aantal gevalle onduidelik. In 'n poging om meer duidelikheid te verkry, is 'n chemotaksonomiese studie van die groep onderneem. 'n Tegniek vir die ekstraksie en isolasie van fenoliese verbindings van *Viscum rotundifolium* Linn. f. is eers ontwikkel. Dié metode is toe gebruik om die fenoliese samestellings van twaalf spesies te ondersoek. Taksonomiese verwantskappe ten opsigte van hierdie tipe verbinding is gevind. Voorstelle met betrekking tot die moontlike betekenis van die gebruik van fenole in studies van die familie word gemaak.

INTRODUCTION

The Loranthaceae is largely a tropical family but also extends into temperate zones of both hemispheres. All the species are parasitic or semi-parasitic woody plants, commonly called mistletoes, which grow on the stems, branches and roots of many trees and shrubs (Fig. 1). There are about 1 300 species in the Loranthaceae, which have been variously grouped into between 12 and 125 genera by different authors (Gill & Hawksworth, 1961).

More than fifty species have been recorded in South Africa of the two genera *Viscum* and *Loranthus*. Species of *Loranthus* can be recognised by their often very attractive and showy flowers which may be as much as 6 cm long and leaves which often resemble those of the host, making them inconspicuous (Fig. 2). The flowers of *Viscum*, on the other hand, are inconspicuous and the leaves in several species are reduced, often to scale-like outgrowths, their function being replaced by flattened stems or cladodes. (Fig. 3).

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FIG. 1.

Acacia karroo Hayne, heavily infested with *Viscum verrucosum* Harv. at Hekpoort, Transvaal.

On the basis of these floral characters and on the presence or absence of a subfloral bract or calyculus, De Candolle (1830) divided the family into two fairly natural subfamilies, the Lorantheae, in which the calyculus is always present below the perianth, and the Viscioideae, which lack the calyculus. Another feature which divides these subfamilies is the position of the vascular tissues of the fruit; internal to the viscin layer in the Lorantheae and external in the Viscioideae (Gill & Hawksworth, 1961). Hegnauer (1963) claimed that the two subfamilies are clearly distinguishable by the production of distinct chemical compounds although their exact nature was not specified.



FIG. 2.

Loranthus rubromarginatus Engl., growing on *Protea caffra* Meisn. at Kenmare, Krugersdorp, Transvaal.

Much taxonomic controversy centres about the genus *Loranthus*, which had approximately 200 species assigned to it by 1830 (Gill & Hawksworth, 1961). The revisions of Danser (1929, 1931, 1933) are widely used in the classification of the Lorantheae. In the last decade various new schemes have been put forward, but these have been largely restricted to species of particular



FIG. 3.

Viscum combreticola Engl., a species with no leaves, their function being assumed by the flattened stems or cladodes, seen growing on *Combretum zeyheri* Sond. at Hartebeestpoort Dam, Brits dist., Transvaal.

areas such as South West Africa, (Balle, 1968), and so embrace only relatively few members of the family.

Balle (1956) made a study of the African species of *Loranthus* and these changes will probably be accepted when a thorough study of the South African representatives has been made. As there is still some doubt as to the status of the species of the genus the older taxonomy is adhered to in this study.

A large number of diagnostic features that have been used in the taxonomy of the family have been reviewed by Barlow (1964) who showed how studies of embryology, palynology and chromosome numbers have revealed many differences between the two subfamilies. Consequently a number of authors (Dixit, 1962; Barlow, 1964; Kuijt, 1968; and Wiens and Barlow, 1971) recognise separate families for the Loranthaceae.

In recent years, due largely to recent advances in techniques such as chromatography and electrophoresis, much information concerning the systematic distribution of certain chemical constituents in plant materials has become available. Many of these substances appear to be stable and unambiguous and it is therefore possible to use them as taxonomic characters to aid in determining the natural relationships between taxa.

Since available information indicated that phenolic compounds separated by chromatographic methods could provide valuable taxonomic information, a study of these substances in the Loranthaceae was planned. These compounds have not been as extensively investigated as other substances, such as essential oils and alkaloids (Alston and Turner, 1963).

Chemotaxonomic studies using phenolic compounds have been carried out on a number of genera, including *Baptisia* (Alston and Turner, 1959, 1963), and *Lotus* (Harney and Grant, 1964) among others. They have been found to be more reliable indicators of species relationships in *Baptisia* than are alkaloids or amino acids (Brehm and Alston, 1964).

Phenolics are widely distributed in various parts of the plant body such as leaves, flowers and seeds. Some, such as anthocyanins, can be regarded as commonly occurring. Bate-Smith (1958) found that phenolics in vegetative tissues are of considerably more systematic value than those present in flowers, for the latter are genetically highly variable and, moreover, their chemical composition is frequently not closely correlated with the systematic position of the plants. On the other hand, a large number of leaf constituents are relatively constant and many are diagnostic for the species (Alston and Turner, 1963).

The phenolic composition of some mistletoes has been studied in recent years. Attention has been focused on chemical substances of medicinal significance, for example, some proteins from *Viscum album* are found to inhibit tumour growth (Vester *et al.* 1968). Samuelsson (1966) has been screening a

large number of species and genera of the Loranthaceae for toxic proteins. However, the first comprehensive chemotaxonomic study of the mistletoes reported in the literature is that of Hawksworth and Wiens (1972) on the genus of dwarf mistletoes, *Arceuthobium*. A more detailed review of the information on the phenolics of mistletoes is given in their publication. Hawksworth and Wiens (1972) carried out a very detailed taxonomic revision of *Arceuthobium* which included the use of 3 anthocyanins and 17 other phenolics (flavones, flavonols, and cinamic acid ester derivatives) in a taximetric study.

The purpose of the present study on the Loranthaceae was firstly to determine a suitable chromatographic technique for separating different phenolic compounds of the species. The technique was then used to examine the phenolic substances of twelve species to ascertain whether or not such chemical information is likely to be of value in the classification of the family.

MATERIALS

A single species, *Viscum rotundifolium* Linn. f., was chosen for a preliminary analysis to determine a satisfactory chromatographic technique. This species is locally abundant, growing on *Ziziphus mucronata* Willd. Leaves of all ages and stems of two different stages were selected for study.

The comparative chemotaxonomy was made using six species of *Viscum* and six species of *Loranthus* which are readily available in South Africa (Table

TABLE 1.
The species, their hosts and localities used in this study.

Species	Hosts	Locality
<i>Viscum rotundifolium</i> Linn. f.	<i>Ziziphus mucronata</i> Willd.	Witpoortjie, Roodepoort dist.
<i>Loranthus dregei</i> Eckl. & Zeyh.	<i>Acacia mellifera</i> (Vahl.) Benth.	Rooibokkraal, Waterberg dist.
<i>L. minor</i> Sprague	<i>Acacia tortilis</i> (Forsk.) Hayne	Rooibokkraal, Waterberg dist.
<i>L. oleaeifolius</i> Cham & Schlecht	<i>Rhus engleris</i> Britt.	Pienaars River, Warmbaths dist.
<i>L. rubromarginatus</i> Engl.	<i>Protea caffra</i> Meisn.	Witpoortjie, Krugersdorp dist.
<i>L. zeyheri</i> Harv.	<i>Acacia caffra</i> Willd.	Witpoortjie, Krugersdorp dist.
<i>L. species</i>	<i>Rhus lancea</i> L.f.	Koegas, Orange River, Kuruman dist.
<i>Viscum capense</i> L.f.	<i>Rhus undulata</i> var. <i>burchellii</i> (Sond.) Schonl.	Sevenfountains, Albany dist.
<i>V. combreticola</i> Engl.	<i>Combretum molle</i> R.Br.	Hartebeestpoort Dam, Brits dist.
<i>V. obovatum</i> Harv.	<i>Vitex pooara</i> Corb.	Nylstroom dist.
<i>V. obscurum</i> Thunb.	<i>Scutia myrtina</i> (Burm. f.) Kurz.	Kasouga, Bathurst dist.
<i>V. rotundifolium</i> Linn. f.	<i>Boscia albitrunca</i> (Burch) Gilg and Benedict	Pienaars River, Warmbaths dist.
	<i>Ziziphus mucronata</i> Willd.	Pienaars River, Warmbaths dist.
<i>V. verrucosum</i> Harv.	<i>Acacia tortilis</i> (Forsk.) Hayne	Pienaars River, Warmbaths dist.

1). The range of hosts and distribution of the species were determined from herbarium records and recorded fully in Tilney (1970). Both leaves and stems were used where appropriate. *Viscum rotundifolium* was analysed from two different hosts. Voucher specimens are deposited in the Moss herbarium, University of the Witwatersrand.

In a study of this nature on parasitic plants there were two problems that had to be alleviated by the selection of suitable material and choice of technique:

1. A number of *Viscum* species lack leaves or possess very reduced leaves. In order to overcome this difficulty, *Viscum rotundifolium*, which is a leafy species, was investigated with respect to the phenolic compounds of stems and leaves, to see if there is a correlation between the chemical constituents of the two organs. If this is the case, it may be inferred that the modified stems or cladodes of the leafless species are likely to be comparable in their phenolic composition to the leaves of the leafy forms. In a similar situation Bate-Smith (1956) regarded the phyllodes of *Acacia* as "leaves" in a study of their phenolic composition.
2. There is also the possibility in parasitic plants that substances produced in the host plant may accumulate in the parasite. Thus the phenolic composition of the mistletoe may be modified by virtue of the nature of its host. To minimise the possibility of host-parasite translocation affecting the results in the preliminary analysis, leaves and stems were taken from a single specimen. In the comparative taxonomy study, one mistletoe species was selected from two different host species to investigate this effect.

METHODS

Leaves and stems of *Viscum rotundifolium* were ground into a powder and phenolics were extracted and separated according to fifteen different techniques, many being different combinations of extraction methods with different solvents. (Brehm and Ownbey, 1965; Graziano *et al*, 1967; Tilney, 1970). In each case, 0.05 ml of the extract was applied to the chromatogram paper and irrigation was carried out in one-dimension.

The dry chromatograms were examined under ordinary light, and ultra-violet light, and after spraying with a concentrated solution of sodium carbonate. The colours and positions of the component spots obtained with the different techniques were marked (Tilney, 1970).

From this preliminary study, the technique which gave a large number of spots and yet showed close affinity between the spots obtained with leaves and stems, was chosen for the detailed taxonomic study. It was assumed that the technique most successful for *Viscum rotundifolium* would be the most suitable one for the other species.

For each of the twelve species, leaf, cladode or stem material was selected, ground and extracted in acidified methanol. This was left overnight in a dark cupboard and then filtered with Whatman number 3 paper. From the extract obtained, 0.05 ml was applied to Whatman number 3 chromatographic paper and irrigated with n-butanol: acetic acid: water in the ratio 4:1:5 (V/V). Development time was 24 hours. Duplicate extractions thus were performed with each species to ensure constancy of results. The chromatograms were all run at the same time so as to subject them all to exactly the same conditions.

The chromatograms were examined in visible light, under ultra-violet light, after exposure to the fumes from a solution of concentrated aqueous ammonia, and in visible light after being sprayed with azolated benzidine. The latter reagent was found to be superior to sodium carbonate as it gives a wider range of colour reactions with phenolics, so that a greater number of compounds could be distinguished.

The positions and colours of the spots obtained for each species extract were marked on the chromatograms. The spots were numbered and the presence or absence of a spot recorded for each species. R_f values for each spot were calculated and compared with known compounds.

In order to express quantitatively the similarities between all pairs of species, the Paired Affinity (P.A.) Indices were calculated (Alston and Turner, 1963).

$$\text{Paired Affinity} = \frac{\text{Spots in common for species A and B}}{\text{Total spots in A and B}} \times 100$$

where A and B represent all possible pairings between the twelve species.

Following the method of Ellison, Alston and Turner (1962) the P.A. Indices were used to construct polygonal graphs for each species. P.A. Indices are expressed from 0 (at the centre of the circle) to 100 (at the periphery of the circle) along the appropriate radii. Each radius represents a different species compared with the species for which a polygonal graph is being constructed. Since there is always one self comparison one value for each graph will always be 100. The advantage of polygonal graphs is that they enable the pattern of biochemical affinity of the various species with that of all others under study to be visualized quickly and with ease. The greater the similarity in shape shown by the polygonal graphs of any two species the more closely they are likely to be related.

The presence of unique substances within a taxon being investigated is potentially of systematic value. The percentage of unique or distinctive compounds within a species has been termed the isolation value (I.V.) by Ellison, Alston, and Turner (1962). The I.V. can be calculated with respect to the grand total of all different compounds for all species investigated (I.V.n.).

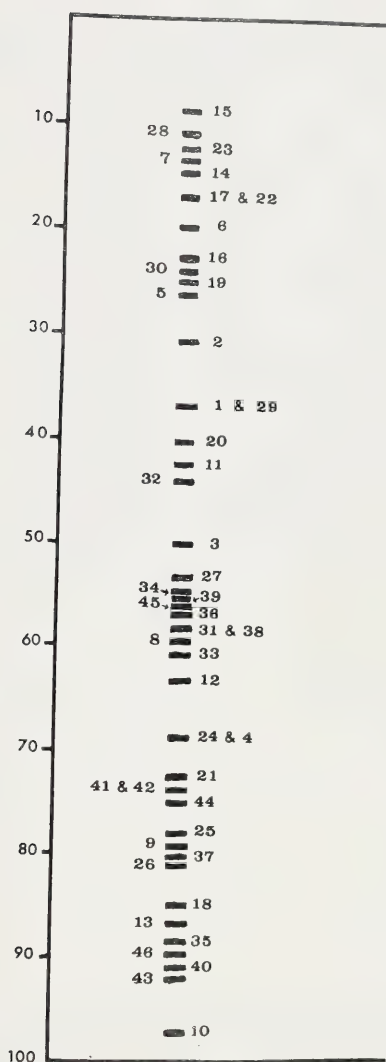


FIG. 4.

Master chromatograph showing the position of each of the thirty-seven compounds and nine standards. The numbers refer to the spot numbers in Table 2.

TABLE 2.

The average R_f values and colour reactions obtained for individual spots and known compounds.

Spot No.	Av. R_f in 4:1:5 (v/v):		Colours observed*				
	Butanol:	Acetic acid: water	Visible	Ultra violet	NH_3 + ultra-violet	NH_3	Benzidine
1		37		B	B		P
2		31		B	B		B
3		51		P	Y	Y	Pi
4		69		B	B	Y	Pi
5		27		B	B		P
6		20		B	B		P
7		14	YBr	YBr	YBr		P
8		60		B	B		PBr
9		80		B	B	Y	WP
10		98	G	O	O	G	G
11		43		B	B	Y	
12		64					O
13		87		P	V		O
14		16	OBr	V	B		RBr
15		9	OBr		YBr		
16		23		Pi	PBr		Pi
17		17	RBr	O	O	M	Br
18		86					L
19		26	C	O	Br	M	BrO
20		41		B	V		OBr
21		73	O	P	Y	Y	Pi
22		17		Y	Y		Y
23		13		P	V		
24		69	Y	P	B	Y	RP
25		79		P	Y	Y	Pi
26		82		P	Br	Y	Pi
27		54		V	V		O
28		12	YO	Y	Y		Br
29		37	RO	Y	Br		O
30		25	RO	B	bY		OBr
31		59		Y	Y	Y	OBr
32		45		B	B		OBr
33		62		V	B		Pi
34		56		B	B		O
35		89		Y	Y		Br
36		58		Pi	Y	Y	Pi
37		81		V	B		OBr
38†		59		B	B		L
39†		57		P			Y
40†		92		B	B		PBr
41†		75	Y	P	B	Y	RP
42†		75		B	B	Y	WP
43†		93		B	B		Br
44†		76		V	V		YBr
45†		57					P
46†		91		dB	B	Y	P

*Legend: B blue Br brown C cochineal red
 G green L lilac M maroon
 O orange P purple Pi pink
 R red V violet W white
 Y yellow b bright d dark

†Known compounds 38 aesculin 43 ferulic acid
 39 arbutin 44 gallic acid
 40 caffeic acid 45 hesperidin
 41 catechin 46 simaric acid
 42 chlorogenic acid

However, when rather distantly related species are compared, it is often more desirable to express the I.V. with respect to the total number of compounds detected in that particular species (I.V.i). Both forms of isolation value were calculated.

RESULTS

Thirty-seven compounds were observed in this study of twelve species. Figure 4 shows the total complement of spots and the R_f values and colour reactions of the individual spots are given in Table 2. The distribution of these compounds in the different species is shown in Table 3. From this table, P.A. Indices were calculated for all possible pairs of the twelve species and the polygonal graphs were drawn (Fig. 5). It is impractical to compare a large number of items in the form of polygonal graphs as a large number of axes would be required, which would render interpretations extremely difficult. Therefore, in species where both leaves and stems are present, the P.A. Indices of the leaves, rather than the stems, were used in drawing the graphs. However, in the case of *Viscum rotundifolium*, where specimens were taken from different host species, four polygonal graphs were drawn. In this way, a comparison could be made between phenolics of stems and leaves and one could also ascertain the influence of the host on the parasites. The isolation values for each species were calculated and recorded in Table 4.

DISCUSSION

Relatively few phenolic compounds were separated out, approximately ten spots per species, when compared with reports in the literature. Ellison, Alston, and Turner (1962) separated between ten and eighteen compounds per species, an average of 13, in a study of the leaves of 17 species of *Bahia*. It appears that *Viscum* and *Loranthus* may be lacking in phenolics. A much wider range of species would, however, have to be considered before reliable generalizations can be made.

On the basis of R_f values and colour reactions, one spot was identified as chlorogenic acid and another was identified as catechin. The former was present in all species of *Viscum*, whereas the latter was found in all species of *Loranthus*.

From the results of the P.A. Indices and polygonal graphs (Fig. 5) a number of interesting facts emerged. In general the species belonging to the genus *Viscum* showed markedly higher affinities with one another than with the species of *Loranthus*. Similarly the species of *Loranthus* showed higher affinities with one another than with species of *Viscum*. On the basis of phenolic composition, therefore, the genera are easily distinguished.

From the polygonal graphs (Fig. 5) of the *Loranthus* species (Numbers 12–22) it will be seen that they are not very similar to those species of *Viscum* (Numbers 1–11). Note also that *L. rubromarginatus* (14), *L. zeyheri* (16), *L. oleaefolius* (20) and *L. minor* (22) have similar patterns. They therefore seem to form a distinct group differing from the remaining two species. *Loranthus dregei* (12) seems to bear very little resemblance to the other species of the genus, whereas the unknown species (18) does show a pattern resembling, to some extent, that of the 4 similar species mentioned above. This unknown species was later given a dubious identification (at the National Herbarium, Pretoria) as *L. oleaefolius* but it differs in phenolic composition from that species (no. 20).

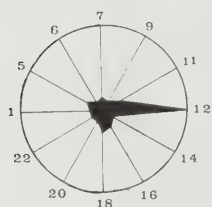
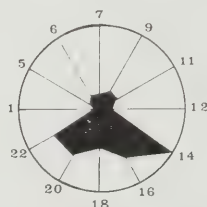
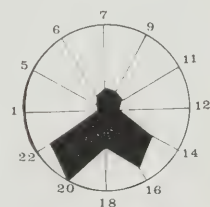
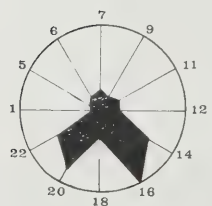
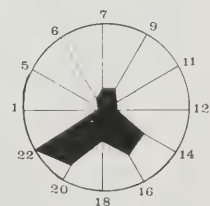
In the case of *Viscum*, 9 polygonal graphs (Fig. 5) were drawn so that a comparison could be shown between the phenolics of leaves and stems in one species, and also the effect of different hosts. The first two graphs depict the phenolic composition of *V. rotundifolium* growing on *Boscia albitrunca*. The next two are also of this parasite but growing on the host *Ziziphus mucronata*. The pattern of the graphs is similar but there is greater similarity between the phenolics of the stems of the parasite growing on the same host. In other words, the effect of different hosts on the phenolic content of the parasites is of less importance in this case than the part of the plant used. There was a P.A. Index of 81,3% between the leaves growing on different hosts and one of 92,3% between the stems, thus indicating that the leaves are affected by the host on which they grow to a greater degree than the stems. These affinity values are high and the differences due to the different hosts insignificant when the generally very low affinities between the other species are considered. *Ziziphus* and *Boscia* may have similar phenolics, thus accounting for the similarities observed in the parasites, but they are only distantly related, belonging to the Rhamnaceae and Capparidaceae respectively, and this explanation seems unlikely. It is more likely, in this case, that the phenolic composition of the host, although having a slight influence, is not so important as to dominate the phenolics of the parasites growing on it. However, in view of the very complex interrelationships of host and parasite, no generalization can validly be made about these translocation relationships without a more thorough investigation.

On examining the polygonal graphs (Fig. 5) of the other species some similarities between *Viscum* species emerge. *Viscum capense* (6) and *V. verrucosum* (5) have fairly similar patterns. Morphologically, they appear very similar, both having rounded cladodes. However, the third species without leaves, *V. combreticola* (11), did not show a high affinity with either of these species, but rather had similarities to *V. obovatum* (7). *Viscum combreticola* differs markedly from the other leafless species, possessing cladodes that are broad

TABLE 4.

Isolation values for species of *Viscum* and *Loranthus*.

Taxon	Number of unique compounds	Total compounds	I.V.n.	I.V.i.
1. <i>V. rotundifolium</i> leaves (<i>Boscia</i>)	5	15	13,5	33,3
2. <i>V. rotundifolium</i> stems (<i>Boscia</i>)	5	13	13,5	38,5
3. <i>V. rotundifolium</i> leaves (<i>Ziziphus</i>)	5	14	13,5	35,7
4. <i>V. rotundifolium</i> stems (<i>Ziziphus</i>)	5	12	13,5	41,7
5. <i>V. verrucosum</i>	0	8	0	0
6. <i>V. capense</i>	0	10	0	0
7. <i>V. obovatum</i> leaves	1	13	2,7	7,7
8. <i>V. obovatum</i> stems	1	15	2,7	6,7
9. <i>V. obscurum</i> leaves	0	13	0	0
10. <i>V. obscurum</i> stems	0	15	0	0
11. <i>V. combreticola</i>	1	14	2,7	7,1
12. <i>L. dregei</i> leaves	3	9	8,1	33,3
13. <i>L. dregei</i> stems	3	11	8,1	27,3
14. <i>L. rubromarginatus</i> leaves	0	9	0	0
15. <i>L. rubromarginatus</i> stems	0	7	0	0
16. <i>L. zeyheri</i> leaves	0	9	0	0
17. <i>L. zeyheri</i> stems	0	8	0	0
18. <i>L. sp.</i> leaves	0	7	0	0
19. <i>L. sp.</i> stems	0	5	0	0
20. <i>L. oleaefolius</i> leaves	0	9	0	0
21. <i>L. oleaefolius</i> stems	0	11	0	0
22. <i>L. minor</i> leaves	0	7	0	0
23. <i>L. minor</i> stems	0	6	0	0

*L. dregei**L. rubromarginatus**L. oleaefolius**L. zeyheri**L. species**L. minor*

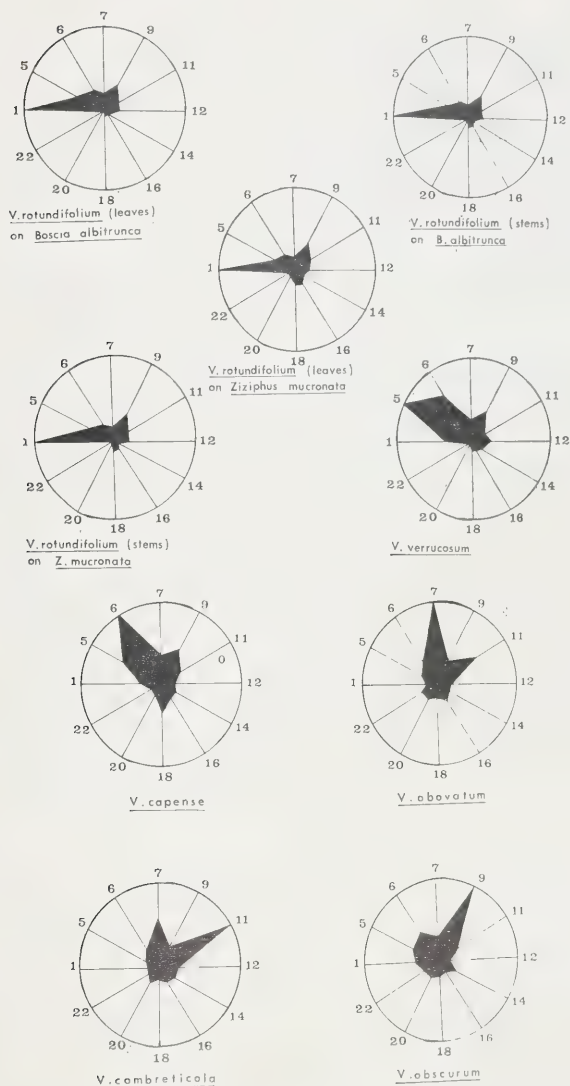


FIG. 5.
Polygonal graphs constructed on the basis of P.A. indices for each of the 12 species.

and flattened. *Viscum obscurum* (9) is not very much like any of the other species, probably being most like *V. obovatum*.

The isolation values (Table 4) emphasize the distinctiveness of *V. rotundifolium* and *L. dregei* from the other species. Similarly, to a lesser degree, *V. obovatum* and *V. combreticola* are seen to differ. It should be noted that half the species of *Viscum* possess at least one unique compound as opposed to a single species of *Loranthus* with unique compounds. This again seems to indicate that the species of *Loranthus* form a more homogeneous group than those of *Viscum*. Because of the general lack of unique compounds (67% had none), the different species cannot be differentiated on this basis.

GENERAL DISCUSSION AND CONCLUSIONS

The narrowness of the spectrum of species investigated obviously limits the interpretation of the results. By studying a much wider range of species of each genus, it should be possible to draw conclusions of general applicability. Such studies may well indicate whether certain species of *Viscum* can in fact be distinguished by unique compounds and whether species of *Loranthus* generally have different combinations of the same phenolics rather than unique or characteristic compounds. It should also be possible to determine whether or not further species could be placed with the four similar *Loranthus* species found in this study to form a distinctive group, and whether others could be grouped with *V. capense* and *V. verrucosum* or with *V. combreticola* and *V. obovatum*.

Loranthus dregei, which was shown to be different from the other species of *Loranthus* studied, has been placed in a separate genus *Erianthemum*, whereas the other species are considered to be species of *Tapinanthus* by some workers (Danser, 1933; Balle, 1956, 1968). This study would support the separation of *Loranthus* with respect to these species, although our conclusions are somewhat limited, as so few species have been studied for phenolics. Similarly any conclusions reached about the sectional classification of *Viscum* are limited by the narrow range of species studied.

With respect to the subdivision of the family into two separate families, evidence from the phenolic compounds would support this view. The chromatographic data clearly indicated definite differences between the phenolic compounds of *Viscum* and *Loranthus* species, but it is difficult to decide whether these differences would indicate family differences rather than subfamily or even only generic differences. It seems more acceptable to take the view of Barlow (1964) and Kuijt (1968) that there are two separate families and that the phenolic compounds give further evidence for this subdivision.

In addition, biochemical studies of the phenolics and other compounds may provide some clues as to the host specificity, which appears to vary widely

from relatively unspecific forms such as *V. rotundifolium* and *L. dregei* to more highly specific forms such as *V. verrucosum* and *V. combreticola*. Thorough investigations of host-parasite relationships are essential. These interrelationships are a critical factor in deciding whether studies of phenolic constituents will be of general use in gaining a better understanding of the taxonomy of the family or whether, in fact, the relationships are too variable and complex depending ultimately on the nature of the host. If the latter is true chemotaxonomic studies may well be too tedious and time-consuming to be of practical value. However, in this study on limited investigation of the variability of the phenolics of *Viscum rotundifolium* growing on different hosts, there was very little variability encountered. Whether these results can be extrapolated to other species is not known.

The chemical characters studied here show chemical relationships between the Loranthaceae species, but they are just one aspect in a complex mosaic. These characters have been shown to be useful and valid but it seems that chemical characters can, at least at present, best be used in conjunction with as many other sources of evidence as possible to obtain a classification that is both natural and phylogenetic.

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BOOK REVIEW

FERNS OF THE WITWATERSRAND, by Florence D. Hancock and Annabelle Lucas, with pp. xiv + 94, and 32 black and white and 4 colour plates. Johannesburg: Witwatersrand University Press, 1973. R7-00.

Although the Witwatersrand and the Transvaal Highveld in general are not endowed as richly with species of ferns and fern allies as some of the milder and more moist parts of South Africa, it still harbours an interesting range of these plants, namely 31 species. The book under review is comprehensive, well produced and a useful addition to South African botanical literature. Each species is described and competently illustrated, which should ensure accurate identification. Useful ecological notes are also included.

There is an explicit introduction to the Ferns and Fern Allies in general, including their life histories and general ecology, the principal features of the main groups and their possible lines of evolution. An interesting and useful feature of the book is an illustrated key to the genera and species, normally only associated with continental European handbooks. The unfortunate transposition of the legends to the *Blechnum* plates has been corrected by inserted corrigenda slips in the review copy, which might otherwise have evoked criticism. The reviewer also welcomes the inclusion in the appendix of what little data is available on the collection of an *Isoetes*, presumably *I. giessii*, from a locality between Springs and Dunnottar, which needs further investigation before the area is completely overtaken by industrial and urban development.

It is clear that this book has been written for the intelligent amateur botanist on the Transvaal Highveld and the reviewer has no hesitation in strongly recommending that this book should be in the private library of anyone who has an interest in Transvaal Highveld plants.

E. A. SCHELPE

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INDEX OF PLANT NAMES

Note: Plant names appearing in tables or lists are not included in this index. Page references to new taxa are printed in bold type. An asterisk indicates an illustration.

	PAGE		PAGE
<i>Acacia alba</i>	91, *95	<i>Amphiasma merenskyanum</i> Brem.	184
<i>A. borleae</i>	*95	<i>Amphineuron opulentum</i> (Kaulf.)	
<i>A. detinens</i>	91	Holtz.	161
<i>A. exuvialis</i>	92, *93	<i>A. terminans</i> (Hook.) Holtz.	162
<i>A. giraffae</i>	9, 91, *95	<i>Amsinckia hispida</i> (Ruiz and Parvon)	
	*97, *98	Jtn.	172
<i>A. grandicormuta</i>	269, *271	<i>Andropogon eucomus</i> Nees	29
<i>A. hereroensis</i>	*95	<i>Aneilema aequinoctiale</i> (Beauv.)	
<i>A. karroo</i>	*270, *316	Knuth	173
<i>A. kirkii</i>	94, *97	<i>Anthospermum</i>	257
<i>A. mellifera</i>	91		
<i>A. pennata</i>	91	<i>Baikiaea plurijuga</i>	9
<i>A. robusta</i>	271, *272	<i>Barberetta aurea</i>	*174
<i>A. schweinfurthii</i>	91	<i>Bauhinia esculenta</i> Benth.	172
<i>Acmadenia laxa</i> Williams	283	<i>B. fassoglensis</i> Kotschy	172
<i>A. sheilae</i> Williams	281	<i>Boscia albitrunca</i>	329
<i>Agathisanthemum bojeri</i> Klotzch	184		
<i>Aloe africana</i> Mill.	75, *77, *78, *79	<i>Ceanothus africana</i>	54
<i>A. andongensis</i> Bak.	*105	<i>Chloris virgata</i> Sw.	29
<i>A. andongensis</i> Bak. var. <i>repens</i> Leach	115	<i>C. gayana</i> Kunth	29, 31
	*116	<i>Christella afzelii</i> (C.Chr.) Holtz.	146
<i>A. arborescens</i> Mill.	75	<i>C. altissima</i> Holtz.	141
<i>A. brownii</i>	75	<i>C. callensis</i> (Alston) Holtz.	146
<i>A. caecia</i> Salm	75	<i>C. chaseana</i> (Schelpe) Holtz.	148
<i>A. ciliaris</i> Haw.	75	<i>C. dentata</i> (Forsk.) Holtz.	143
<i>A. concinni</i>	75	<i>C. distans</i> (Hook.) Holtz.	140
<i>A. esculenta</i> Leach	121	<i>C. friesii</i> (Brause) Holtz.	145
<i>A. guerrae</i>	*118	<i>C. queinziana</i> (Mett.) Holtz.	147
<i>A. humilis</i>	75	<i>C. quineensis</i> (Chr.) Holtz.	145
<i>A. lepidia</i> Leach	102, *104, *105	<i>C. hilsenbergii</i> (Presl) Holtz.	142
<i>A. metallica</i>	104	<i>C. microbasis</i> (Bak.) Holtz.	146
<i>A. procera</i> Leach	117, *117, *118, *119	<i>C. modesta</i> Holtz.	144
		<i>C. multifrons</i> (C.Chr.) Holtz.	145
<i>A. scorpiodes</i> Leach	106, *107, *108	<i>C. parasitica</i> (L.) Lév.	140
<i>A. Todari</i> var. <i>praecox</i> Borzi	75	<i>Cleome angustifolia</i> Forssk.	172
<i>A. vallis</i> Leach	111, *112, *113	<i>Cliffortia</i>	257
<i>A. variegata</i>	75	<i>C. odorata</i>	52
<i>A. varvari</i> Borzi	75	<i>Cnestis natalensis</i> (Hochst. ex Krauss)	
<i>Alsophila capensis</i> (L.f.) Sm.	57	Planch. & Sond.	173
<i>Amauropelta bergiana</i> (Schlechtend.)		<i>Combretum zeyheri</i> Sond.	*318
Holtz.	133	<i>Commiphora africana</i>	9
<i>A. heteroptera</i> (Desv.) Holtz.	132	<i>Cunonia capensis</i>	52
<i>A. membranifera</i> (C. Chr.) Holtz.	132	<i>Cyanella alba</i> L.f.	*174, 176
<i>A. oppositifolia</i> (C.Chr.) Holtz.	135	<i>C. capensis</i> L.	176
<i>A. strigosa</i> (Willd.) Holtz.	134	<i>C. lutea</i> L. f.	*174, 176
<i>A. tomentosa</i> (Thouars) Holtz.	134	<i>C. orchidiformis</i> Jacq.	176
<i>Ampelopteris prolifera</i> (Retz.) Copel.	153	<i>Cyclosorus interruptus</i> (Willd.) H.	
<i>Amphiasma divaricatum</i> (Engl.)		Ito	152
Brem.	184	<i>C. striatus</i> (Schum.) Ching	151

	PAGE		PAGE
Cyclosorus totus (Thumb.) Pic. Serm.	152	Hyparrhenia hirta (L.) Stapf	29, 31
Cynodon dactylon (L.) Pers.	29, 31	Hyphaene natalensis Kunze	189
Danthonia	257, *265	Jasminum angulare Vahl	179
Darlingtonia californica	66, 70	J. breviflorum Harv.	179
Dionaea muscipula	66, 70	J. fluminense Vell.	179
Diosma apetala (Dümmer) Williams	278	J. glaucum (L.f.) Ait.	179
D. oppositifolia L.	276	J. multipartitum Hochst.	179
D. rubra L.	275	J. quinatum Schinz	179
Diospyros whyteana (Hiern) F. White	57	J. streptopus E. Mey.	179
Disa racemosa	52	Leucadendron argenteum (L.) R. Br.	57
Drosera aliciae Hamet	65, *71	Loranthus dregei	328
D. auriculata	66, 70	L. minor	328
D. cuneata	52	L. oleaeifolius	328
D. peltata	66, 70	L. rubromarginatus Engl.	*317, 328
Drosophyllum lusitanicum	65, 70	L. species	328
Dryopteris pseudogoeintziana Bonap.	148	L. zeyheri	328
Duthiella De Vos	301	Macrothelypteris torresiana (Gand.)	
D. linifolia (Phill.) De Vos	302, *303, *306, *307, *23	Ching	126
Duvalia maculata		Menisorus pauciflorus (Hook.) Alston	154
Dyerophyllum indicum (Gibs. ex Wight) O. Kuntze	183	Metathelypteris fragilis (Bak.) Holtt.	127
Eichhornia crassipes	184	Nesaea kuntzei Koehne	178
Eleusine indica (L.) Gaertn.	29	N. rivularis (Wood & Evans) Koehne	178
Eragrostis	257	N. sagittifolia (Sond) Koehne	178
Erica	257, *265	N. schinzii Koehne	178
E. obliqua Thunb.	57	N. woodii Koehne	178
E. sexfaria Bauer	57	Nivenia binata Klatt	*170, 177
E. triflora L.	54, 57	N. corymbosa (Ker) Baker	177
Erythroxylum brownianum Burt-Davy	173	N. dispar N.E. Brown	177
E. delagoense Schinz	173	N. stokoei (Guthrie) N. E. Brown	*170, 177
E. emarginatum Thonn.	173	Noltea africana (L.) Reich.f.	57
Euchaetis diosmoides (Schltr.) Williams	280	Nymphoides thunbergiana (Griseb.) O. Kuntze	*170, 179
E. elsieae Williams	85	Oxalis caprina L.	180
E. pungens (Bartl. and Wendl.) Williams	279	O. compressa L.f.	180
E. scabricosta Williams	286	O. dines Ornduff	180, 181
Eucomis nana (Burm f.) L'Hérit.	61	O. disticha Jacq.	*170, 180
E. regia (L.) L'Hérit.	61	O. fallax Jacq.	179
Festuca	257	O. glabra Thunb.	180
Geissorhiza heterostyla L. Bolus	178	O. incarnata L.	180
Greyia flanaganii H. Bol.	193	O. luteola Jacq.	179
G. radlkoferi Szyszyl	193, *198	O. macrogyna Jacq.	179
G. sutherlandii Hook. & Harv.	193, *197	O. massoniana Salter	180, 181
Halleria lucida L.	52, 54, 57	O. monophylla L.	181
Harpechloa	257	O. obtusa Jacq.	180
Helichrysum	257, *265	O. pes-caparae	182
Huernia andreaena (Rauh) Leach	21	Oxalis purpurea L.	180
H. procumbens	*23	O. pusilla Jacq.	180
H. tanganyikensis	*22	O. uliginosa Schlecht.	180
H. verekeri Stent var. angolensis Leach	19	O. versicolor L.	180
Hydrocotyle asiatica	52	Oldenlandia affinis (R. & S.) DC	184
		O. caespitosa Hiern.	184
		O. capensis L.f.	184
		O. corymbosa L.	184
		O. herbacea (L.) Roxb.	184

	PAGE		PAGE
<i>Oldenlandia muscosa</i> Brem.	184	<i>Rhus lucida</i> L.	54, 57
<i>O. rosulata</i> K. Sch.	184	<i>Royena lucida</i>	54
<i>O. rupicola</i> (Sond.) O. Ktze.	184	<i>Sarracenia flava</i>	66, 70
<i>Parathelypteris salazica</i> Holtt.	136	<i>S. purpurea</i>	66, 70
<i>Paspalum dilatatum</i> Poir.	29	<i>Sebaea grandis</i> (E. Mey.) Stendel *170, 173	
<i>Pentanisia variabilis</i> Haw.	184	<i>Serruria flagellaris</i> R. Br.	49
<i>Pentodon pentander</i> (Schum.) Vatke	184	<i>S. foeniculacea</i> R. Br.	49
<i>Piriqueta caroliniana</i> (Walt.) Urb.	184	<i>Setaria flabellata</i> Stapf	29
<i>Plumbago auriculata</i> Lam.	183	<i>Sphaerostephanos arbuscula</i> (Willd.) Holtt.	164
<i>Poa</i>	257	<i>S. elatus</i> (Bojer) Holtt.	167
<i>Podocarpus latifolius</i> (Thunb.) R. Br. ex Mirb.	57	<i>S. subtruncatus</i> (Bory) Holtt.	165
<i>Pogonarthria squarrosa</i> (Licht.) Pilg. 29, 31		<i>S. unites</i> (Linn.) Holtt.	165
<i>Polypodium capense</i>	52	<i>Stegnogramma pozoi</i> (Lagasca) K. Iwats.	149
<i>Protea acuminata</i> Sims	299	<i>Sutera esculenta</i> Bond	311, *312
<i>P. caffra</i> Meisn.	*317	<i>Syringodea bicolor</i> Baker	235, *236
<i>P. canaliculata</i> Andr.	299	<i>S. concolor</i> (Baker) De Vos *204, *232, 233	
<i>P. denticulata</i> Rourke	291	<i>S. derustensis</i>	*204, *244, 245
<i>P. holosericea</i> (Salis. ex Knight) Rourke	297, *298	<i>S. flanaganii</i> Baker	237
<i>P. repens</i> (L.) L.	57	<i>S. longituba</i> (Klatt) Kuntze	*204, 239
<i>P. scolopendriifolium</i> (Salis. ex Knight) Rourke	296	<i>S. longituba</i> var. <i>violaceae</i>	*240
<i>P. speciosa</i> L.	57	<i>S. pulchella</i> Hooker	*204, 229, *230
<i>P. subulifolia</i> (Salis. ex Knight) Rourke	299	<i>S. saxatilis</i> De Vos	246, *248
<i>P. vogtsiae</i> Rourke	293, *295	<i>S. unifolia</i> Goldblatt	*204, 249, *250
<i>Pneumatopteris afra</i> (Chr.) Holtt.	157	<i>Taraxacum fulvipilliss</i>	313
<i>P. blastophora</i> (Alston) Holtt.	156	<i>Thelypteris confluens</i> (Thunb.) Mor- ton	150
<i>P. comorensis</i> Holtt.	160	<i>Themeda</i>	257
<i>P. humbertii</i> Holtt.	158	<i>T. triandra</i>	72
<i>P. oppositifolia</i> (Hook.) Holtt.	157	<i>Trichocaulon mossamedense</i> Leach 15, *17	
<i>P. prismaticus</i> (Desv.) Holtt.	160	<i>Turnera ulmifolia</i> L.	184
<i>P. remotipinna</i> (Bonap.) Holtt.	159	<i>Villarsia capensis</i> (Houtt.) Merrill	179
<i>P. subpennigera</i> (C. Chr.) Holtt.	157	<i>Viscum album</i>	319
<i>P. unita</i> (Kunze) Holtt.	155	<i>V. capense</i>	329
<i>P. usambarensis</i> Holtt.	159	<i>V. combreticola</i> Engl.	*318, 329
<i>P. venulosa</i> (Kuntze) Holtt.	159	<i>V. obovatum</i>	329
<i>Pseudocyclosorus camerounensis</i> Holtt.	137	<i>V. obscurum</i>	329
<i>P. johannae</i> Holtt.	138	<i>V. rotundifolium</i> Linn.f.	315, 329
<i>P. pulcher</i> (Bory ex Willd.) Holtt.	138	<i>V. verrucosum</i> Harv.	*316, 329
<i>Pseudophegopteris aubertii</i> (Desv.) Holtt.	129	<i>Wachendorfia brachyandra</i>	*174, 176
<i>P. cruciata</i> (Willd.) Holtt.	129	<i>W. paniculata</i>	*174, 175
<i>P. diana</i> (Hook.) Holtt.	128	<i>Wormskioldia longipedunculata</i> Maxw.	184
<i>P. henriquesii</i> (Bak.) Holtt.	128	<i>Ziziphus mucronata</i> Willd.	320, 329
<i>Pyrhopappus taraxacoides</i> DC	313		





